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THE PSYCHOLOGY OF SPIRITUALISM.

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IN 1848, from the town of Hydeville, New York, came the somewhat startling discovery that certain knockings, the source of which had mystified the household of one of its residents, seemed to be intelligently guided and ready to appear at call. Communication was established by agreeing that one rap should mean "no," and three raps "yes"; to which was afterward added the device of calling off the alphabet and noting at which letters the raps occurred; in this way the rapper revealed himself as the spirit of a murdered peddler. Within five years the news of this simple and childish invention had called into existence thousands of spirit-circles, had developed wonderful "mediums," through whose special gifts the manifestations were ascribed, had amassed a vast store of strange testimony, and the movement had become an epidemic; and this, too, in spite of the fact that, in 1851, the peculiar double raps occurring in the presence of these Fox sisters *

* Since this article was written, Margaret Fox (now Mrs. Kane) and Katie Fox (now Mrs. Jencken) have publicly confessed that the raps to which they as children gave rise were produced by dislocations of the toes. They have publicly shown the method of their production, and seem earnestly desirous of retarding the growth of the movement to which they so unintentionally gave rise. They plead for our mercy, on the ground that the movement was started when they were too young to appreciate what was being done, and that, when they realized the fraud and the encouragement they were receiving, it was too late or too difficult to retract. It is a pity that this confession comes so late, and the more so, that it has been made under such sensational surroundings. Had the confession been placed in the hands of a respectable scientific body, such as the Scybert commission, a more lasting service to mankind would have resulted. But none the less is it proper to derive from this confession a valuable lesson for intending investigators, and a characteristic proof of the moral taint in which the germs of this growth were laid and have developed.

were satisfactorily explained as due to the rapid partial dislocation and resetting of the knee-joint, and perhaps other joints, the raps failing to occur when the Fox sisters were placed in a position in which the leverage necessary for this action was denied them and being perfectly repeated, at will, by a lady gifted with the same peculiarity. To-day spiritualists count their adherents by millions. In 1867 there were estimated to be three millions in America. They publish about one hundred journals, hailing from all parts of the world (twenty-six of them appear in America), and the manifestations have increased in number and variety. Spirit-forms are seen and hold converse; they write on slates in mysterious ways, they move tables, play musical instruments, send flowers and messages, tie knots in an endless cord, and so on; all, however, only in the presence of "mediums."

It would seem self-evident that so momentous a conclusion should not be accepted without the most rigid scrutiny; that only after every attempt to explain the phenomena by laws already understood had failed, would recourse be had to a supernatural origin, and only when the truth of such a theory had been repeatedly verified by a variety of evidence would it be definitely accepted. The history of psychic epidemics shows too clearly that any such logical procedure is made impossible by the white heat of the emotional interest with which such movements always spread. There is always a large class of people yearning for a possession that shall be mysterious and unshared by the common herd, anxious to embrace any such strange and novel doctrines as spiritualism advanced, simply because of their strangeness and novelty. Such persons find no satisfaction in investigating, but only in believing. With such the movement began; but, as it spread, it found its way into higher circles, securing the adherence of many men and women of decided culture and intellectual acumen, and even enrolling in its cause a few eminent representatives of the world of learning. The spiritualists grew bold and defied investigation; investigations were frequently made, and resulted, according to the ability, impartiality, and technical fitness of the investigators, about as frequently in exposure as in conversion. The conversions were always trumpeted far and wide, while the mediums convicted of fraudulent procedure quietly and successfully continued their career. A prominent spiritualist openly announces that Slade (perhaps the most famous living medium) "now often cheats with an almost infantile audacity and *naïveté*, while at the same or the next *séance* with the same investigators," genuine spiritualistic phenomena occur. If this is the moral atmosphere of spiritualism, one can readily understand the opinion of another disciple, that the true spirit in which to approach its study is "an entire willingness to be deceived."

With the revival of interest fostered by the Society for Psychic Research, the investigation of spiritualistic manifestations has been undertaken with more of a scientific appreciation of the problems therein involved; and within the last few years have appeared the results of several inquiries that deserve to register a turning-point in the career of this mischievous superstition and to hasten the day of its abandonment by all sensible men.

Mr. Henry Seybert, an enthusiastic spiritualist, bequeathed to the University of Pennsylvania a sum of money, on the condition that this university should appoint a commission to investigate modern spiritualism. This commission has published a preliminary report.* They began with an entire willingness to accept any conclusion warranted by facts; and their chairman, Dr. H. H. Furness, confessed "to a leaning in favor of the substantial truth of spiritualism." They have examined many of the most famous mediums. and the manifestations that have contributed most to their fame. Their verdict, individually and collectively, is the same regarding every medium with whom they saw anything noteworthy: *gross, intentional fraud throughout.* The mediums were treated with the utmost fairness and courtesy; their conditions were agreed to and upheld; every one, in each kind of manifestation, was either caught in the act of trickery, or the trick was repeated and explained by one of the commission. This testimony goes far to justify the substitution of "trick" for "manifestation," of "senseless cant" for "spiritualistic explanation," of "adroit conjurer" for "medium." The accumulative force of this conclusion can only be appreciated by a reading of the report itself. A few examples of the kind of trickery exposed must here suffice.†

Dr. Slade, whose mediumship has convinced many of the most eminent believers in spiritualism, including the famous Zöllner *coterie*,‡ produces communications on a slate held beneath a table,

* "Preliminary Report of the Commission appointed by the University of Pennsylvania, to investigate Modern Spiritualism," Philadelphia, 1887, Lippincott, pp. 159. The members of the commission are: Dr. William Pepper, Dr. Joseph Leidy, Dr. G. S. Koenig, Prof. R. E. Thompson, Prof. G. S. Fullerton, Dr. H. H. Furness, Mr. Coleman Sellers, Dr. J. W. White, Dr. C. B. Knerr, and Dr. S. Weir Mitchell.

† It is often claimed that, while mercenary purposes can explain the existence of professional mediums, the manifestations of private mediums remain as the bulwark of faith. It is doubtless true that the method of investigating private manifestations must be a different one, and this yet remains to be done in a careful and scientific manner. The difficulty has always been in the unwillingness of private mediums to appear before examining bodies. It must also be remembered that amateur mediums, even when there was no ground for suspicion, have been exposed as frauds (*vide* "Seybert Report," p. 122); and the passion for deceiving, so characteristic of hysterical natures, is as strong as the greed for gain. The subject merits a separate discussion.

‡ This is always cited as one of the triumphs of spiritualism. As usually told, it reads that a few eminent scientists, especially fitted to investigate such matters, were convinced

in answer to questions asked in writing or verbally, sometimes openly and sometimes in folded slips of paper. It was soon discovered that the character of this writing was of two kinds. The long messages were neatly written, with the *i's* dotted and the *t's* crossed, and often produced unasked, or not in direct answer to a question; while the short ones, in answer to questions asked only shortly beforehand, were scrawly, hardly legible, and evidently written without the aid of the eye. The many methods of producing the short writings were repeated by a professional prestidigitateur much more skillfully than by Slade. The commission distinctly saw every step in Slade's method, on one occasion or another, but were utterly baffled by the conjurer (Mr. Harry Kellar), who subsequently revealed his methods to Dr. Furness. The long messages are written beforehand, on slates to be substituted for the ones given him at a favorable opportunity. At the last *séance* with Dr. Slade, two prepared slates were resting against a table behind him, and Dr. Furness kept a sharp watch upon these slates. "Unfortunately, it was too sharp; for one second the medium saw me looking at them. It was enough. That detected look prevented the revelation of those elaborate spirit messages. But when the *séance* was over, and he was signing the receipt for his money, I passed round behind his chair and pushed these slates with my foot, so as to make them fall over, whereupon the writing on one of them was distinctly revealed." The medium at once pushed back his chair, snatched the slates, hurriedly washed them, and could with difficulty regain sufficient composure to sign the receipt for the exorbitant payment of his services. This is not the first time that Slade has been exposed, and it is hoped that this verdict of the Seybert commission, "fraudulent throughout," will be sufficient to make further exposure unnecessary.*

Another medium, Mrs. Patterson, gives a closely similar performance. Dr. Knerr had a sitting with her, and adjusted a mirror

of the supernatural origin of Slade's performances, and one of their number (Zöllner) found the theory of their explanation in harmony with the mathematical notions of the fourth dimension of space. Prof. G. S. Fullerton, the secretary of the Seybert commission, has interviewed Zöllner's associates, and finds that, "of the four eminent men whose names have made famous the investigation, there is reason to believe one, *Zöllner*, was of unsound mind at the time, and anxious for an experimental demonstration of an already accepted hypothesis (the fourth dimension of space); another, *Fechner*, was partly blind, and believed because of Zöllner's observations; a third, *Scheibner*, was also afflicted with defective vision, and not entirely satisfied in his own mind as to the phenomena; and a fourth, *Weber*, was advanced in age, and did not even recognize the disabilities of his associates." None knew anything about conjuring, and, deservedly honored as these men are in their own specialties, they were certainly not fitted to compete with a professional like Slade.

* Another member of the commission (Mr. Coleman Sellers) says, with regard to Slade: "The methods of this medium's operations appear to me to be perfectly transparent, and I wish to say emphatically that I am astonished beyond expression at the confidence of this

about his person so as to reflect whatever was going on beneath the table. "In the mirror I beheld a hand . . . stealthily insert its fingers between the leaves of the slate, take out the little slip (containing the question), unfold and again fold it, grasp the little pencil . . . and with rapid but noiseless motion . . . write across the slate from left to right a few lines; then the leaves of the slate were closed, the little pencil laid on the top," and the spirits invoked to please send a message.

Is it necessary to continue the catalogue of vulgar deceit: to tell how Dr. Furness sends out sealed letters the contents of which the spirits are to read and answer without opening, and finds the seals tampered with and mucilage and skill used to conceal the crime; how he asks the same question of various mediums and receives hopelessly contradictory answers; how he detects the form of the medium in her assumed materializations and finds the spirit ready to answer to any and every name in fiction or reality, from "Olivia" of "The Talking Oak" to Shakespeare; how a medium who materializes a right hand while apparently holding his neighbor's hand with both his own, is shown to imitate this double grip with one hand and do the hocus-pocus with the other—in short, how universal, how coarse, how degrading this fraud is; how readily it leaves its hiding-place to snatch at a cunningly offered bait, until it becomes ridiculous? *

Let us rather turn to another independent investigation published by the English Society for Psychical Research (October, 1886, to May, 1887). The great English medium, whose performances as described are really miraculous, is Englinton, and his specialty is slate-writing. The late Prof. H. Carvill Lewis (of Philadelphia) had sittings with Englinton, and reported as follows: He sat intently watching Englinton for an hour, and nothing happened; fearing a blank *séance*, he purposely diverted his attention. The moment he looked away, the manifestations began, and he could see "the medium look down intently toward his knees and

man in his ability to deceive, and at the recklessness of the risks which he assumes in the most barefaced manner. The only reason of our having any so-called 'manifestations,' under the circumstances, was because of the fact that the committee had agreed in advance to be entirely passive, and to acquiesce in every condition imposed."

Mrs. Sidgwick, an able English observer, detected the fraudulent character of Slade's performances from the beginning. She points out five important grounds of suspicion: "His conjurer-like way of trying to distract one's attention, his always sitting so as to have the right hand to manipulate the slate, the vague and general character of the communications, his compelling one to sit with one's hands in a position that makes it difficult to look under the table, and his only allowing two sitters at a time."

* The barefacedness of the medium's business reaches its climax in the fact (communicated to me by Dr. Furness) that a noted medium had visited a professional juggler, and, "*making no secret to him of his trickery as medium for independent slate-writing, had purchased from the juggler several other tricks with which to carry on his spiritualistic trade.*"

in the direction of the slate. I now quickly turned back my head, when the slate was brought up against the table with a sharp rap." He repeated the manœuvre, with the same result, and while the writing was going on he distinctly saw "the movement of the central tendon in his wrist corresponding to that made by his middle finger in the act of writing. Each movement of the tendon was simultaneously accompanied by the sound of a scratch on the slate." Again, for the answer to another question, Englinton requires the use of a dictionary, and leaves the room for a minute; the answer is then written just as it is given in Webster's dictionary; but, unfortunately, *albumina* was read for *alumina*. When the slate, which closes with a spring, is to be closed, Englinton suddenly sneezes; when the writing is small and faint, he struggles until he gets within a few inches of it; a postage-stamp secretly glued across the two leaves of the double slate prevents all manifestations; a double fee immediately causes further manifestations, while a minute before such were declared impossible, owing to the exhaustion of power; and the writing on the slates is identified by an expert as that of Englinton.*

Mrs. Henry Sidgwick records her experience with many mediums, and supports the same verdict. She was often unable to detect the exact *modus operandi* of the medium, but has never seen anything which was not well within the range and strongly suggestive of conjuring, and mostly of no high order of conjuring.

But all this accounts for only part of the problem. To convict every medium of fraud is not a complete explanation of the appearance which this belief now presents. It remains to account for the great success of the movement; for the fact that so many have been deceived and so few have really understood; to show why we are to believe the Seybert commission, and not credit the countless miracle-mongers. This is psychologically the most interesting portion of the problem, and has recently been very successfully treated by Mrs. Sidgwick, Mr. Hodgson, and Mr. Davey, of the English Society for Psychic Research.

There is a very broad-spread notion that anybody can go to a spiritualistic *séance* and give a reliable opinion as to whether what he or she has seen is explicable as conjuring or not. Especially in this country, where the right to one's opinion is regarded as a corollary to the right of liberty, does this notion prevail. The

* If further proof be required of the degrading contrivances to which this medium will resort, we have it in his conviction of connivance with Mme. Blavatsky in the production of a spurious theosophic marvel, as well as in the following evidence supplied by Mr. Padshah and indorsed by Mr. Hodgson (the exposer of Mme. Blavatsky): Mr. Padshah and a friend had asked for Gujerati writing at a *séance*, but did not get it; the former then anonymously sent a poem in Gujerati to Englinton, and his friend (who was not initiated in the trick) brought the same copied in every detail on a slate as the direct revelation of the spirits in a sitting with the medium!

fact probably is, that most such claimants are about as competent to form a trustworthy opinion on such a subject as they are to pronounce upon the genuineness of a Syriac manuscript. The matter is as much a technical acquisition as is the diagnosticating of a disease. It is not at all to the discredit of the observing powers or the intellectual acumen of any one, to be deceived by the performances of a conjurer, and the same holds true of the professional part of mediumistic phenomena.* Until this homely but salutary truth is impressed with all its importance upon all intending investigators, there is little hope of checking the growth of this vast superstition.† You believe that there will be an eclipse of the moon when the astronomer predicts one, not because you can calculate the time yourself, or even understand how the astronomer does it, but because that is a technical acquisition which

* "I do not think that this unpreparedness and inobservancy of mind, in the presence of a conjurer, is a thing of which any one who is not familiar with the tricks already need be ashamed."—*Mr. Hodgson.*

Even a conjurer can be nonplussed by a medium's performance if he have no experience in the particular kind of sleight of hand required for the trick. This is the experience of Mr. Harry Kellar. He at first declared himself unable to explain slate-writing as a trick, but now can repeat the process in a variety of ways, and with far greater skill than mediums. Of course the spiritualists keep on citing his former testimony, and ignore his challenge to repeat by trickery any alleged spiritualistic phenomena witnessed by him three times.

† The above view ought, perhaps, to be modified somewhat. There is a class of spiritualistic manifestations, to be deceived by which is a mark of weak insight or strong prejudice. To this class belong the materialization of departed friends. On these Dr. Furness writes thus: "Again and again men have led round the circles the materialized spirits of their wives and introduced them to each visitor in turn; fathers have taken round their daughters, and I have seen widows sob in the arms of their dead husbands. Testimony such as this staggers me. Have I been smitten with color-blindness? Before me, as far as I can detect, stands the very medium herself, in shape, size, form, and feature true to a line, and yet one after another, honest men and women at my side, within ten minutes of each other, assert that she is the absolute counterpart of their nearest and dearest friend; nay, that she *is* that friend. It is as incomprehensible to me as the assertion that the heavens are green, and the leaves of the trees deep blue. Can it be that the faculty of observation and comparison is rare, and that our features are really vague and misty to our best friends? Is it that the medium exercises some mesmeric influence on her visitors, who are thus made to accept the faces which she wills them to see? Or is it, after all, only the dim light and a fresh illustration of *la nuit tous les chats sont gris!*" Add to this the confession of an exposed medium, Mr. D. D. Home: "The first *séance* I held, after it became known to the Rochester people that I was a medium, a gentleman from Chicago recognized his daughter Lizzie in me after I had covered my small mustache with a piece of flesh-colored cloth, and reduced the size of my face with a shawl I had purposely hung up in the back of the cabinet." Cases where different members of a circle instantly recognize in the spirit form entirely different persons are not uncommon. Here so much of the trick depends upon the sitter that he must be a firm believer, or very simple, to be deceived. It is this kind of manifestations with which the better class of spiritualists have least to do; and it is seldom that a conversion of a real investigator begins with such materializations. This preying upon the feelings of simple-minded folk is one of the greatest scandals of the movement.

he has learned and you have not; and so with a thousand other and more humble facts of daily life. Spiritualism (to a large extent) comes under the same category; and the Seybert commission, and these other observers who have acquainted themselves with the possibilities of conjuring and the natural history of deception, who by their training and natural gifts have fitted themselves as competent judges of such alleged ultra-physical facts—these persons have the same right to our confidence and respect as a body of chemists or physicians on a question within their province. It is not fair to set up what you think you have seen as overthrowing their authority; even if you are an unprejudiced and accurate observer who has weighed the probability of your observations being vitiated by one or other of the many sources of error in such observation, it is only a small fact, though of course even that should be registered.

Whatever of seeming dogmatism there is in this view is removed by the experimental demonstration furnished by Messrs. Hodgson and Davey, that the kind and amount of mal-observation and faulty description which an average observer will introduce into the account of a performance such as the medium gives, is amply sufficient to account for the divergence between his report of the performance and what really occurred. The success of a large class of tricks depends upon diverting the observer's attention from the points of real importance, and in leading him to draw inferences perfectly valid under ordinary circumstances but entirely wrong in the particular case. It must be constantly remembered that the judging powers are at a great disadvantage in observing such performances, and that it is a kind of judgment in which they have no practice. In the intercourse of daily life a certain amount of good faith and confidence in the straightforwardness of the doings of others prevents us from exercising that close scrutiny and suspicion here necessary. We know that most of our neighbors have not the sharpness to deceive us, and do not live on the principle of the detective, who regards every one as dishonest until he has proved himself honest.

Mr. Davey (who, by the way, was at one time deceived almost into conversion by spiritualistic phenomena) is an expert amateur conjurer, and repeats the slate-writing performances of such as Englinton with at least equal skill. He arranged with Mr. Hodgson to give sittings to several ladies and gentlemen, on the condition that the latter send him detailed written accounts of what they had seen. He did not pose as a medium or accept a fee, but simply said that he had something to show which his sitters were to explain as best they could, and with due consideration of trickery as a possible mode of explanation. The "medium" has here a decided advantage over Mr. Davey, because he induces a mental

attitude in his sitters that entertains (however remotely) the possibility of witnessing something supernatural, and this is sufficient to create an adjustment of the powers of observation less fitted to detect trickery than if the performer did not announce himself as the go-between of the supernatural. This is well illustrated in the reports of Mr. Davey's sitters, for a few friends who were told beforehand that they were to witness a sleight-of-hand performance, or were strongly led to believe it such, made much less of a marvel of the performance than those who had not been thus enlightened. It remains to add that not one of the sitters (and they were persons of decidedly more than average intelligence and ability) detected his *modus operandi*, and a large number concluded that trickery was utterly insufficient to account for the manifestations.

Mr. Davey's performances, *as described* by many of his sitters, like the descriptions of the performances of many a medium, are marvelous enough to demand the hypothesis of occult agency: "Writing upon slates locked and carefully guarded by witnesses —writing upon slates held by the witnesses firmly against the under surface of the table—writing upon slates held by the witnesses above the table—answers to questions written secretly in locked slates—correct quotations appearing on guarded slates from books chosen by the witnesses at random, and sometimes mentally, the books not touched by the 'medium'; . . . messages in languages unknown to the 'medium,' including a message in German, for which only a mental request had been made, and a letter in Japanese in a double slate locked and sealed by the witness, etc. And yet, though 'autographic' fragments of pencil were 'heard' weaving mysterious messages between and under and over slates, and fragments of chalk were seen moving about under a tumbler placed above the table in full view, none of the sitters witnessed that best phenomenon, *Mr. Davey writing.*"

It must not be supposed that the errors of mal-description and lapse of memory thus committed are at all serious in themselves; on the contrary, they are mostly such as would be entirely pardonable in ordinary matters. Mr. Hodgson places them in four classes. In the first, the observer *interpolates* a fact which really did not happen, but which he was led to believe had occurred. He records that he examined the slate, when he really did not. Or, for similar causes, he *substitutes* one statement for another closely like it; he says he examined the slate minutely, when he really only did so hastily. Thirdly, he may *transpose* the order in which the events happened, making the examination of the slate occur at a later period than when it really took place. Lastly, he may *omit* certain details which he was carefully led to consider trivial, but which really were most important. Such slight lapses

as these are sufficient to make a marvel of a clever piece of conjuring; add to this the increased temptations for mal-observation afforded by the dim light and mysterious surroundings of the medium, as well as by the sympathetic attitude of the sitters, and the wide divergence between the miraculous narratives of spiritualists and the homely deceptions which they are intended to describe is no longer a mystery.

The conclusion thus experimentally arrived at by Messrs. Hodgson and Davey is corroborated by other investigators. After witnessing a *séance* that was simply a series of the simplest and most glaringly evident tricks, Mrs. Sidgwick was expected to have had all her doubts entirely removed, and was assured that what she had seen was better than the materializations at Paris. "Experiences like this make one feel how misleading the accounts of some completely honest witnesses may be; for the materializations in Paris were those which the Comte de Bullet had with Firman, where near relatives of the count were believed constantly to appear, and which are among the most wonderful recorded in spiritualistic literature. And, after all, it appears that these marvelous *séances* were no better than this miserable personation by Haxby."

The Seybert commission finds that "with every possible desire on the part of spiritualists to tell the truth, the whole truth, and nothing but the truth, concerning marvelous phenomena, it is extremely difficult to do so. Be it distinctly understood that we do not for an instant impute willful perversion of the truth. All that we mean is that, for two reasons, it is likely that the marvels of spiritualism will be, by believers in them, incorrectly and insufficiently reported. The first reason is to be found in the mental condition of the observer; if he be excited or deeply moved, his account can not but be affected, and essential details will surely be distorted. For a second reason, note how hard it is to give a truthful account of any common, every-day occurrence. The difficulty is increased a hundred-fold when what we would tell partakes of the wonderful. Who can truthfully describe a juggler's trick? Who would hesitate to affirm that a watch, which never left the eye-sight for an instant, was broken by the juggler on an anvil; or that a handkerchief was burned before our eyes? We all know the juggler does not break the watch, and does not burn the handkerchief. We watched most closely the juggler's right hand, while the trick was done with his left. The one minute circumstance has been omitted that would have converted the trick into no-trick. It is likely to be the same in the accounts of the most wonderful phenomena of spiritualism."

If we desire a concrete instance of this omission of an impor-

tant detail, Dr. Furness will supply one. Certain highly intelligent observers describe to him the doings of a Boston medium: "There are two tables in the room of *séance*, at one of which sits the medium, at the other the visitor. The visitor at his table writes his question in pencil at the top of a long slip of paper, and, after folding over several times the portion of the slip on which his question is written, gums it down with mucilage and hands it to the medium, who thereupon places on the folded and gummed portion his left hand, and in a few minutes with his right hand writes down answers to the concealed questions; these answers are marvels of pertinency, and prove beyond a cavil the clairvoyant or spiritual powers of the medium." Dr. Furness went to the medium, prepared his slip of paper about as described, and thus continues: "As soon as he took his seat, and laid the strip on his table before him, I rose and approached the table so as to keep my paper still in sight; *the row of books entirely intercepted my view of it.* The medium instantly motioned to me to return to my seat, and, I think, told me to do so. I obeyed, and as I did so could not repress a profound sigh. Why had no one ever told me of that row of books?"

Before passing sentence one must hear what the defendant has to say. The usual defense consists in claiming that the conviction of fraud in some mediums does not prove the absence of genuine phenomena in others. Some even claim, as we saw, that fraud and spirit manifestations can go hand in hand. Furthermore, they hold that the conditions for success demanded by the mediums, though they make the phenomena resemble a juggler's performance, are perfectly explicable on spiritualistic grounds. Writing is best produced in the dark because dark is "negative," light "positive," and negative conditions are most favorable to communication; if the spirit that appears resembles the medium, that is an effect of the materializing process; if writing does not occur when the slate is looked at, it is because the magnetism of the eye is unfavorable; and has not Dr. Slade received an express command from the spirits forbidding him, on penalty of cutting off all communication, to attempt to write on sealed slates?

In the first place, while it is not thus proved that every action of every medium is fraudulent, it makes it more and more probable, especially as the very conditions necessary for a serious investigation are denied on fanciful grounds. The fact that scientific examination everywhere reveals deception makes it extremely probable that, when exposure has not taken place, it is because there was no scientific examination. At any rate, the burden of proof is with the claimants for supernatural manifestations, and their case has now been so much weakened that it can no longer

enter as a serious possibility into the minds of such as guide their beliefs by reason. Again, their "spiritualistic" explanations are simply violent assumptions, varying with the caprice and ingenuity of every medium, and evidently manufactured for the purpose. Even if such explanations were consistent, they would be possible only in that extreme sense in which any bizarre notion or fantastic hypothesis is possible. Practically, they are impossible, because contradictory to the fundamental tenets of science and experience; because they are opposed to that marvelous network of mutually corroborating laws and observations upon which the logic of civilization is founded. Those whose feelings are not appealed to by the doctrines of spiritualism will never be attracted to it by its logic.

A system that aims to instruct men with regard to beliefs appealing most earnestly and deeply to the human heart, appears in the light of scientific investigation as an empty, tottering framework, held together by the grossest frauds, covered over with the most vulgar sham, and embellished with the meanest kind of deception. Let each one leave as small or as large a margin for the possibility of a genuine spiritualism as to him seems fit, but let him realize in all its immensity the gross scandal to which this system has given and is giving rise. Let him understand that under the shelter of spiritualism men and women in all our large cities are daily and hourly preying upon the credulity of simple-minded folk, and obtaining money by means for which the law provides the jail. Let him know that there is now abundant evidence to make the term "medium" synonymous with "impostor." When these facts are clearly and universally recognized, we may hope to ascertain whether there is a true but small foundation-stone hidden beneath this rubbish-heap, or whether, like its equally pretentious predecessors, it leaves the mystery as unsolved as it found it.

ACCORDING to Prof. Judd, an important change has taken place in scientific opinion concerning the climatical relations of fauna and flora, and the distribution of biological regions. It has been tacitly assumed that all marine organisms coming from regions bordering the equator must have lived under tropical conditions; but deep-sea research has shown that all conditions of temperature and of light prevail at their several depths in tropical as well as other seas; and that many forms which, because they came from equatorial regions, we have hitherto regarded as tropical, we now know to live in icy-cold water as well as in almost utter darkness. The large size and abundant development of cephalopods, crustaceans, and fish, we now know to be no evidence of the presence of warmth or life, and Sir Joseph Hooker has shown the fallacy of similar reasoning when applied to plant-life.

THE CHEMICAL ELEMENTS:

HISTORY OF THE CONCEPTION WHICH THIS TERM INVOLVES.

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THE intellectual force of Aristotle ruled in chemistry even longer than in other departments of physical science. In mechanics and astronomy the dogmas of Aristotle were effectually laid by Galileo early in the seventeenth century; but his doctrine of the four elements*—in one form or other—was accepted in chemistry to the close of the eighteenth century. The wonderful history of the philosophy of the great Stagirite—a philosophy which ruled the intellectual world in physics as well as in metaphysics for more than twenty centuries—is constantly referred to as an illustration of the vices of speculative thought when not based on experimental evidences; and, undoubtedly, the aberrations of many of his later disciples justify this opinion. Among these Kepler is especially conspicuous, for he, by applying the doctrines in a most grotesque and absurd manner, did not a little to bring Aristotle's philosophy of mechanics into contempt. Nevertheless, Aristotle himself was for his time an acute observer, as his writings abundantly indicate; and his philosophical views are brought forward rather to justify his conclusions than as the basis of his inferences. So it is with the doctrine of the four elements. Earth, water, air, and fire were obviously to him the essences, or, to use a later and more descriptive word, the "substantia" of four conditions of matter. Three of these we recognize as clearly as he did; and the fourth, fire, which he regarded as a more sublimated condition than air, and thought he actually saw in the upward motion of flames, has its modern representative in Mr. Crookes's fourth condition of matter.

Since Aristotle regarded motion as an attribute of inanimate as well as of living bodies—a stone falling for the same reason that a fish swims—and as he noticed that while water and stones tend to fall, flame and air tend to rise, he regarded the last as having a natural motion upward, and the first as having a natural motion downward; and thus to him specific levity seemed as much a direct inference of observation as specific gravity. By this inherent motion the four elements appeared to strive to separate, and each to tend to its own place—fire taking the highest place, air the

* The doctrine of the four elements, although usually associated with Aristotle, is really as old as Greek philosophy, and can certainly be traced back to Empedocles, who lived in the second third of the fifth century before Christ—that is, a century before the time of Aristotle.

next, water the next, and earth the lowest. The reasons urged in support of these conclusions appear to us absurd enough.

By Aristotle, as by other Greek philosophers, the contrasts emphasized by language were regarded as fundamental distinctions in nature, or first principles, which they made the basis of discussion, and from which they sought to deduce general truths. Aristotle enumerates ten such principles as enunciated by the Pythagoreans—limited and unlimited, odd and even, one and many, right and left, male and female, rest and motion, straight and curved, light and darkness, good and evil, square and oblong—and from oppositions of this kind he deduced his doctrine of the four elements.

"We seek," Aristotle writes, "the principles of sensible things, that is, of tangible bodies. We must take, therefore, not all the contrarieties of quality, but those only which have reference to the touch. Thus, black and white, sweet and bitter, do not differ as tangible qualities, and must therefore be rejected from our consideration. Now, the contrarieties of quality which refer to the touch are these: hot, cold; dry, wet; heavy, light; hard, soft; unctuous, meager; rough, smooth; dense, rare." Then, after rejecting all but the first four of these, either because they are not active and passive qualities, or because they are combinations of the first four, and concluding for these reasons that the four retained must be elements, he proceeds: "Now, in four things there are six combinations of two; but the combinations of two opposites, as hot and cold, must be rejected. We have, therefore, four elementary combinations which agree with the four apparently elementary bodies: fire is hot and dry; air is hot and wet (for steam is air); water is cold and wet; earth is cold and dry."

In a similar way, by considering light as opposite to heavy, Aristotle justifies his conclusion that levity is a quality of a body, and that bodies are absolutely heavy or absolutely light. "Former writers," he says, "have considered heavy and light relatively only—taking cases where both things have weight, but one is lighter than the other, and they imagined that in this way they defined what was absolutely heavy and light." Fire and air, according to Aristotle, were absolutely light, with fire the lighter of the two; while water and earth were absolutely heavy, with earth the heavier of the two. In another place he writes, "Heavy and light are, as it were, the embers or sparks of motion"; and hence he concluded that the tendency of light bodies to rise, like the tendency of heavy bodies to fall, was an inherent quality.

Subsequently Aristotle recognized a fifth element in nature. In his book "On the Heavens" he wrote: "The simple elements must have simple motions; and thus fire and air have their natural motions upward, and water and earth have their natural

motions downward. But, besides these motions, there is motion in a circle, which is unnatural to these elements, but which is a more perfect motion than the other, because a circle is a perfect line, and a straight line is not; and there must be something to which this motion is natural. From this it is evident that there is some essence of body different from those of the four elements, more divine than those and superior to them. If things which move in a circle move contrary to nature, it is marvelous or rather absurd that this, the unnatural motion, should alone be continuous and eternal; for unnatural motions decay speedily. And so from all this we must collect that, besides the four elements which we have here and about us, there is another removed far off, and the more excellent in proportion as it is more distant from us." This element was called the *quinta essentia* by Latin writers, and the word *quintessence* in our own language frequently brings to mind this singular conception, which, although so absurd to us, held for ages a wonderful control over the human mind.

It is not, however, our purpose to trace the influence of the dynamical conceptions of Aristotle on the development of physical science, interesting and instructive as such a study would be. We are here dealing only with the conception of an element or principle of material bodies, also involved in this reasoning; and it is obvious that this early conception of an element was not that of a definite substance—as we now understand the word substance—that is, something *subsistens per se*—but rather that of the *essentia* or *substantia* which were supposed to underlie the external attributes of bodies, and of which these last were merely accidents. Earth was the underlying principle of all solid bodies, whose multifarious forms were as familiar to Aristotle as to us. So all liquid bodies were forms of water, and all aëriform bodies manifestations of the all-diffusive air; and the ancients, at times even more acute than ourselves, made distinctions between conditions, both of water and air, which we know are not essential.

We know that flame is simply intensely heated gas rising in a denser atmosphere; but it was perfectly natural that the ancients should regard such a startling effect as a manifestation of a fourth condition of matter still lighter and more subtile than air, and the conception of fire as a fundamental principle of nature once formed, the phenomena of combustion appeared to them as direct evidences of the escape of this principle of fire from the burning bodies.

The famous theory of phlogiston, advanced by Becher and Stahl during the seventeenth century, was simply a development of these views without any essential change. Phlogiston was merely a new name for the fourth element of Aristotle. As by Aristotle all combustible bodies were assumed to hold the principle of fire,

so, on the new theory, they were regarded as compounds of phlogiston, and, in burning, the phlogiston was supposed to escape into the atmosphere. The ease with which such metals as zinc, iron, lead, and tin burn under certain conditions was well known to the chemists of that period, and hence all metals were regarded as largely composed of phlogiston; and when it was shown that the oxides, then called *calces*, resulting from the burning, weighed more than the metal burned, the facts were cited to prove that phlogiston was specifically light, and therefore, when removed from a body, added to its weight.

It has been said that the increase of weight resulting from burning and other forms of oxidation was not recognized until Lavoisier introduced the balance into chemical investigations at the close of the last century; but, although such phenomena could not be formulated under a general principle until after the discovery of oxygen in 1774 (nearly simultaneously both by Priestley and by Scheele), the fact that the so-called *calces* resulting from the burning of the metals weigh more than the metals was well known to metallurgists from a much earlier period. Thus Lémery, who died in 1715, in his well-known treatise on chemistry, describes the increase of weight attending the calcination both of tin and lead; and Boerhaave, a famous Dutch physician and chemist of the same period, thus describes the calcination of lead: "And if, while the lead is in fusion, it be kept continually stirring with a spatula, it turns into a red powder called minium, or red lead, in which operation this is further observable that the lead augments in weight."

During the eighteenth century the theory of phlogiston became modified by the increasing knowledge of the definiteness of chemical combination. Like the other constituents of a body, it was held that the phlogiston in combustibles must be united in definite proportions. So, moreover, when, leaving the fuel in the process of combustion, phlogiston entered into union with the air, it could only be absorbed by the atmosphere up to a certain limit. Hence, a candle soon goes out if burned in a confined vessel; because, after the air is saturated with phlogiston, no more can escape from the combustible. Priestley called oxygen gas, when first discovered, dephlogisticated air, because he ascribed its wonderful power of sustaining combustion to the absence of phlogiston, which oxygen gas could therefore absorb to a proportionally great extent. On the other hand, hydrogen was called phlogisticated air; and Cavendish, when he first isolated this exceedingly light and combustible gas, thought he had discovered phlogiston itself.

As has been already intimated, Aristotle's doctrine of the chemical elements was, in some form or other, received by stu-

dents of chemistry down to the time of Lavoisier, and the aims and practice of alchemy, which for many centuries was the only phase of chemistry studied, were wholly in harmony with this conception. If the metals were all manifestations of the same underlying essence, and differed only in the accidents of external qualities, it was reasonable to suppose that these accidents might be changed. The alchemists were often intelligent men, and knew as well as ourselves that "all is not gold that glitters"; but the resemblances to the precious metals which they sometimes obtained by their empirical methods were sufficient to stimulate effort. They also clearly saw that the value of the prize they sought would vanish in their keeping the moment the secret became known; but this only led them, as it does so many manufacturers of the present day, to invest their processes with all possible mystery, to conceal known facts beneath non-essentials, and to adopt a conventional and highly figurative language for communicating with each other, so that, even with our knowledge of chemistry, the writings of the alchemists are for the most part an unintelligible jargon. Still, their hopes were based on what they regarded as sound philosophy; and, although their efforts were frequently exposed to ridicule on the ground of ill success, no convincing objections were ever raised to the philosophy by which they were guided. That the aims of the alchemists must have appeared reasonable to thinking men is shown by the fact that, even at a late period in the history of this apparent delusion, Sir Isaac Newton, whose scientific sobriety can not be questioned, devoted a great deal of time to experiments on the transmutation of the metals.

During the two thousand years through which the doctrine of a few elementary principles of nature prevailed, the precise form which the elements assumed naturally varied with the general point of view of the students at the time, although for the most part philosophical writers adhered to the statement of Aristotle. By many of the alchemists mercury, sulphur, and salt were regarded as fundamental principles, because the crude materials under these names played such an important part in the hermetic art. Here, however, it was not these crude materials which were regarded as the elements of matter, but sublimated forms of these substances, known as the mercury and sulphur of the philosophers; and for a long time the conceit was cherished that, if once the elemental mercury and sulphur could be isolated, all metals, and, of course, gold and silver among the number, could be manufactured by mixing these elements in the right proportions. Later, when chemistry assumed a pharmaceutical character, the elements were often said to be water, spirit, oil, salt, and earth, of which the first three were regarded as active and the last two as

passive principles. These elements, again, were not definite substances, but merely classes of products obtained by distillation, the active principles being those that passed over and the passive principles those that remained behind in this process—a process which at the time had become the typical process of chemistry, and the chemists of this period are always represented in paintings with a retort or alembic, as were the alchemists of an earlier period with a furnace and crucible. This last enumeration of elements is not so different from that of the alchemists as would at first sight seem, for mercury was regarded as the most active of the spirits, and sulphur as one of the oils. Moreover, the distinction between fixed and volatile oils, which dates from this period, shows the generic character of the elements then accepted.

In his "Œdipus Chymicus," first published about the middle of the seventeenth century, Becher, the author of the theory of phlogiston, comes back to the elements of Aristotle, and in this he is followed by Stahl, who elaborated the same theory a generation later. To give an idea of the confusion of thought on this subject, even at a comparatively late period, I will quote from the "Cours de Chimie, par M. Lémery, nouvelle édition, Paris, 1756," a work which remained one of the chief authorities on chemistry down to the time of Lavoisier. I translate freely from the French:

"The first element of compound bodies which we must accept is a universal spirit, which, being universally diffused, produces different results according as it is held in different matrices or pores of the earth; but as this principle is somewhat metaphysical and can not be perceived by the senses, we must distinguish in addition certain elements which are perceptible. I shall name those commonly accepted.

"As chemists in analyzing different compounds have found five kinds of substances, they have concluded that there are five principles of material things—water, spirit, oil, salt, and earth. Of these five there are three which are active principles—spirit, oil, and salt; and two passive—water and earth. The first are called active, because, being endowed with rapid motion, they determine the active qualities of the products into which they enter; and the second are called passive, because, being at rest, they only serve to diminish the vivacity of the active principles."

Then follows a more precise definition of the several principles enumerated, to which in part I have already referred. After this, Lémery remarks:

"The term principle of chemistry must not be taken in an exact sense, for the substances to which we have given this name are principles only relating to our knowledge, and so far as we have been unable to go further in the division of bodies. But we

can well understand that these principles may be further divisible into an infinity of parts, which should more properly be called principles. We understand, then, by principles simply such substances as have been separated and divided so far as our feeble efforts are capable of doing." Here is a glimmering of scientific principles. And so again in this sentence:

"Some modern philosophers would persuade us that it is uncertain whether the products we draw from compounds, and which we call principles of chemistry, really exist as such in the compounds. They say that fire, rarefying matter in the process of distillation, is capable of giving an entirely different arrangement to the parts from that which existed before, and may thus form the salt, oil, and other products which are the results of the process."

Lémery himself died in 1715, so that the edition of his work from which we quote was published over forty years after his death, showing that in the slow progress of knowledge at that time the life of a scientific treatise was far longer than it is now. The editor of the new edition adds copious notes, in which he comments on some of the absurdities of his author, plainly indicating that progress toward clearer views was constantly being made; but, at the same time, his own remarks are equally amusing, and give abundant evidence of the utter confusion of thought which still prevailed. To appreciate how great a work Lavoisier accomplished, it is only necessary to read a few pages (more would be intolerable), both of this treatise of Lémery and also of the "New Method of Chemistry" of Boerhaave, the two great standard works on the science of the eighteenth century, both in large quarto volumes. These are far less repulsive than the chemical writings of the previous century, which often dwelt at great length on illustrations of chemical processes from the relations of the sexes. They are less mystical, and frequently describe acute observations of phenomena; but they are equally deficient in scientific spirit, full of crudities and empiricisms of the most trivial kind, and this at a period when the mathematical sciences had attained much of the elegance of form of our own day. Lavoisier is known to us chiefly as the discoverer of the true theory of combustion, but he was truly the father of modern chemistry, and his claim to our regard rests more than anything else on the fact that he gave to the subject for the first time a definite and rigid scientific form. It will help you to appreciate the entire change of conception introduced by Lavoisier if I quote from Fourcroy's "Chemical Philosophy," third edition, 1806, the following significant passage. Fourcroy was a contemporary of Lavoisier, although twelve years younger. Lavoisier, as is well known, fell a victim of the Reign of Terror during the French Revolu-

tion in 1794. Fourcroy, more fortunate than his greater colleague, passed through this fearful period unharmed, although he was a member of the Constituent Assembly, and after the fall of Robespierre acted as Secretary of Public Instruction. He was made senator by Napoleon, and died full of honors in 1809, living until the decomposition of the alkalies and alkaline earths had become accomplished facts. As before, I translate from the French very freely:

"Since the revolution effected in chemistry between 1774 and 1784" (the period of Lavoisier's active scientific work) "by the new discoveries which have entirely changed the face of the science, many of the former erroneous and arbitrary distinctions have been given up. The term *principle* is no longer used except in a very general sense, and with the understanding that it applies to different sorts of bodies, some of them simple and some of them compound, depending on the nature of the materials from which they come and on the method of analysis used. All chemists agree to-day that if by principles or elements we understand the original and simple bodies which constitute the primitive molecules of substances, such bodies are wholly unknown, either as regards their number or their properties, and that in discussing them we are yielding to theories as useless as those of monads or atoms. They further agree that if we confine the word *elements* to the last products of analysis which can not be subdivided by analytical means, we must exclude from this class of bodies both the so-called principles of the elder chemists and the four elements of Aristotle, as many of these are compound substances, and we must accept a very much larger number of elements than formerly, for we are acquainted with more than thirty substances which can not be decomposed.

"From the results of numerous and exact analyses chemists know, first, that all natural substances may be divided into simple and compound substances; secondly, that the true distinction of primary or simple substances is ability to resist decomposition, so that the word simple is synonymous with the word undecomposable; thirdly, that by compounds we signify substances which are susceptible of analysis, or from which we can extract materials more simple, or of which the complexity of composition diminishes in degree as the analysis is extended; fourthly, that although compounds of the same class may differ greatly among themselves, it is sufficient for comparison and gives us an exact distinction if we divide them into binaries or compounds formed of two elements, ternaries or compounds formed of three elements, quaternaries or compounds formed of four elements, quinaries, sextaries, etc., according as the number of the constituent elements increases; fifthly, that the number of the constituent principles or compo-

nents is not the only cause of the differences which distinguish compounds, but that the proportions in which these elements are united, and perhaps also the mode of their union, are other causes of these differences.

"Thus the whole doctrine of the pretended elements, or of the principles of things, or of their components, or of the compositions of different orders of compounds, is now reduced to conceptions as simple as they are precise. There are no hypotheses or useless distinctions or erroneous abstractions in the present ideas of chemists, and the obscurity which formerly reigned in this part of the science has wholly disappeared, and at the same time we have got rid of a source of vague and endless discussions. We have no longer to dwell in the schools on useless questions about a primitive matter and its relations; on whether there are four, three, two, or only a single element; on the pretended relations of the elements among themselves; on their transformation, or on the change of one into another. All these dreams of a sham speculative philosophy have vanished before the facts discovered by the experimental method; and the five propositions enunciated above, as simple as they are true, are data on which we can now securely build."

Turning, now, to Lavoisier's own "Traité élémentaire de Chimie," which must be regarded as the "Principia" of chemical science, we find, for the first time in the history of the subject, a list of twenty-five definite substances distinguished as elementary on the sole basis that they had as yet never been analyzed. This list is given in the first column of the table which we reproduce in translation on the following page, on account of its very great historical interest. Still, there is even here an obvious survival of Aristotle and the phlogiston theory, both in what the list includes and in what it omits. The first name on the list is caloric, and three of the other elements are the muriatic, fluoric, and boracic radicals, which, though not yet isolated, appear to Lavoisier so distinctly typified and foreshadowed that he does not hesitate to name them in this list. These radicals, it must be noticed, were radicals which, united to oxygen, would form respectively hydrochloric, hydrofluoric, and boracic acid, so that in the last case only were Lavoisier's expectations realized in the form which he expected. Indeed, the radical of muriatic acid, chlorine, was then a well-known substance, having been discovered by Scheele in 1774, but so little did it answer to the expected radical that it was regarded by Lavoisier as an oxide, and named by him "acide muriatique oxygéné," and under this name appears in this very table (translated oxidized muriatic acid). What we know as chlorine gas was classed by Lavoisier as the fourth degree of oxidation of his assumed muriatic radical, while muriatic acid itself was the

TABLE OF THE BINARY COMBINATIONS OF OXYGEN WITH OXIDABLE AND ACIDIFIABLE METALLIC AND NON-METALLIC SUBSTANCES.

	Combinations of oxygen with—	FIRST DEGREE OF OXIDATION.		SECOND DEGREE OF OXIDATION.		THIRD DEGREE OF OXIDATION.		FOURTH DEGREE OF OXIDAT'N.	
		New names.	Old names.	New names.	Old names.	New names.	Old names.	New names.	Old names.
Simple non-metallic substances.	Caloric	Oxygen gas.	Vital, or dephlogisticated air.						
	Hydrogen	We only know of one degree of combination of oxygen and hydrogen, and that combination forms water.							
	Nitrogen	Nitrous oxide, or base of the nitrous gas.	Nitrous gas.	Nitrous acid.	Fuming nitrous acid.	Nitric acid.	Non-fuming nitrous acid.	Oxidized nitric acid.	Unknown.
	Carbon	Oxide of carbon.	Unknown.	Carbonous acid.	Unknown.	Carbonic acid.	Fixed air.	Oxidized carbonic acid.	Unknown.
	Sulphur	Oxide of sulphur.	Soft sulphur.	Sulphurous acid.	Sulphurous acid.	Sulphuric acid.	Vitriolic acid.	Oxidized sulphuric acid.	Unknown.
	Phosphorus	Oxide of phosphorus.	Residue from the combustion of phosphorus.	Phosphorous acid.	Volatile acid of phosphorus.	Phosphoric acid.	Phosphoric acid	Oxidized phosphoric acid.	Unknown.
	The muriatic radical.	Muriatic oxide.	Unknown.	Muriatous acid.	Unknown.	Muriatic acid.	Marine acid.	Oxidized muriatic acid.	Dephlogistic'd marine acid.
	The fluoric radical.	Fluoric oxide.	Unknown.	Fluorous acid.	Unknown.	Fluoric acid.	Unknown to the ancients.		
	The boracic radical.	Boracic oxide.	Unknown.	Boracous acid.	Unknown.	Boracic acid.	Sedative salt of Homberg.		
Simple metallic substances.	Antimony	Gray oxide of antimony.	Gray calx of antimony.	White oxide of antimony.	White calx of antimony. Diaphoretic antimony.	Antimonic acid.			
	Silver	Oxide of silver.	Calx of silver.			Argentic acid.			
	Arsenic	Gray oxide of arsenic.	Gray calx of arsenic.	White oxide of arsenic.	White calx of arsenic.	Arsenic acid.	Arsenical acid.	Oxidized arsenic acid	Unknown.
	Bismuth	Gray oxide of bismuth.	Gray calx of bismuth.	White oxide of bismuth.	White calx of bismuth.	Bismuthic acid.			
	Cobalt	Gray oxide of cobalt.	Gray calx of cobalt.			Cobaltic acid.			
	Copper	Reddish-brown oxide of copper.	Reddish-brown calx of copper.	Green and blue oxide of copper.	Green and blue calx of copper.	Cupric acid.			
	Tin	Gray oxide of tin.	Gray calx of tin.	White oxide of tin.	White calx of tin, or putty of tin.	Stannic acid.			
	Iron	Black oxide of iron.	Ethiops martial.	Yellow and red oxide of iron.	Ochre and rust.	Ferric acid.			
	Manganese	Black oxide of manganese.	Black calx of manganese.	White oxide of mang'nese	White calx of mang'ese	Manganic acid.			
	Mercury	Black oxide of mercury.	Ethiops mineral.	Yellow and red oxide of mercury.	Turbith mineral. Red precipitate. Precipitate *per se*.	Mercuric acid.			
	Molybdenum.	Oxide of molybdenum.	Calx of molybdenum.			Molybdic acid.	Acid of molybdenum.	Oxidized molybdic acid.	Unknown.
	Nickel	Oxide of nickel.	Calx of nickel.			Nickelic acid.			
	Gold	Yellow oxide of gold.	Yellow calx of gold.	Red oxide of gold.	Red calx of gold. Purple precipit. of Cassius.	Auric acid.			
	Platinum	Yellow oxide of platinum.	Yellow calx of platinum.			Platinic acid.			
	Lead	Gray oxide of lead.	Gray calx of lead.	Yellow and red oxide of lead.	Massicot and minium.	Plumbic acid.			
	Tungsten	Oxide of tungsten.	Calx of tungsten.			Tungstic acid.	Acid of tungst'n	Oxidized tungstic acid.	Unknown.
	Zinc	Gray oxide of zinc.	Gray calx of zinc.	White oxide of zinc.	White calx of zinc. Pompholix.				

third degree of oxidation of the same radical. It was left for Davy to demonstrate the elementary nature of chlorine and to discover the true relations of the hydrogen acids. Lavoisier regarded oxygen as the universal acidifying principle, and the facts known in his day admitted of this interpretation; and it is interesting to see how they were worked up in the table; but when a class of acids containing no oxygen came to be clearly recognized, they proved a serious embarrassment to the Lavoisierian system as it was developed by Berzelius and his associates.

With the exception of caloric and two of the radicals above referred to, Lavoisier's list of elements includes no substance not regarded as elementary at the present day; but the list is as remarkable for what it omits as for what it includes. There were then known, and had been known for a long time, two very well marked classes of bodies called alkalies and earths which readily combined with acids to form salts. In this respect these bodies closely resembled the known metallic oxides, as they did also in most cases in their general appearance, and they were classed by Lavoisier with the oxides under the general term of "bases salifiables." Still, they had never been decomposed, and, according to the spirit of Lavoisier's philosophy, ought to have been classed among elementary substances; but Lavoisier's classificatory instinct was altogether too acute to permit him to fall into any such error. He enumerates these bodies, and, although he speaks doubtfully in regard to them, he never for a moment questions their compound nature. In regard to the earths he says their composition is wholly unknown, implying, of course, that they were compounds, and under the head of "Des Substances métalliques" is this significant paragraph:

"It is probable that we only know a part of the metallic substances which exist in nature. All those, for example, which have more affinity for oxygen than for carbon can not be reduced or brought to a metallic state, and must appear to us as oxides which we mistake for earths. It is very probable that baryta, which we have classed as an earth, is a case in point. When experimented upon, it exhibits characters which closely approach those of metallic substances. It may be, indeed, that all the substances to which we give the name of earths are only metallic oxides that can not be reduced by the means which we use."

It will be noticed that the alkalies are not included under this remark, for their active qualities are very different from those of an insipid, earthy-looking, metallic oxide; and their resemblance to ammonia, the volatile alkali, a known compound of nitrogen, was constantly a confusing circumstance. Lavoisier discusses the question whether potash and soda pre-exist as such in the plants from whose ashes they are procured, and makes the suggestion

that they may result from the combined action of the oxygen and nitrogen of the atmosphere on the organic materials in the process of burning. Fourcroy goes still further. In his work on "Chemical Philosophy," to which I have referred, he writes (translation):

"We do not understand the composition of potash. It has been suspected that it might result from a union of lime with nitrogen, because it is often found in vegetables mixed with this earth; but this theory, which I brought forward some fifteen years ago, has not been proved by any positive fact." It is interesting to go back and watch this groping in the dark for what is now positive knowledge, but the experience may teach us many a valuable lesson, and will at least help us to realize the intense enthusiasm with which, on October 6, 1807, Davy saw metallic globules running from a lump of caustic potash under the influence of the current of his new voltaic battery.

With this great achievement of Davy the formative period of the Lavoisierian system of chemistry may be said to have closed; but in this connection it is amusing to notice that in a chemical text-book studied in Harvard College by the class of 1815, and given me by the late Hon. John G. Palfrey, of that class, the alkalies and earths are included in the list of chemical elements, and Davy's discovery is only briefly referred to in a note.

Immediately after Davy's short but brilliant career, the science of chemistry took the form which it retained for nearly fifty years—a form in which it was first studied by all the older men of the present generation. The form was essentially that given by Lavoisier, and its chief merit was the simplicity of the classification, and the admirable nomenclature in which this classification was expressed. This nomenclature, which is to a great extent still retained, although the terms have lost most of their original significance, was devised by Lavoisier, with the co-operation of several of his associates, and adopted with the sanction of the French Academy of Sciences. It was a masterly production, and very greatly strengthened the hold which the system acquired at all the great centers of learning. The general features of the Lavoisierian system can be stated in few words.

Oxygen, which constitutes at least one half of the earth's crust, is the common cement by which all the elementary parts are held together. It is the universal acidifying principle, and the salifiable bases owe their peculiar relations to the same element as well. The elements may be divided into metals and non-metallic substances. The direct compounds of the non-metals with oxygen in different proportions are acids, while the compounds of the metals with oxygen are salifiable bases, and the compounds of the acids and bases are salts; and simple salts may still further combine with each other to form double salts. Thus, beginning with the

elements, combination proceeded, pair and pair, until all terrestrial products were educed. The members of each class of these products were designated by specific names, regularly formed and easily remembered.

Such a simple system could easily be comprehended and presented in such works as that of the late Dr. Turner, and, illustrated by the brilliant phenomena of combustion, had a great charm. I can remember most distinctly the impression it made on me as a boy, and I have heard many learned men, among others my late colleague, Dr. Asa Gray, speak in the most glowing terms of the impression it made on them.

Lavoisier himself regarded his system as perfectly true to nature, and often affirms that he accepts no conclusion not based on experimental evidence; but, with the progress of knowledge, the system soon became highly artificial. Indeed, it never would have been formulated had not its author's vision been restricted to the narrow field that had been cultivated in his time. As investigation extended, the class of hydrogen acids, and their products, which Lavoisier had hidden away under a mistaken interpretation of their constitution, assume an ever-increasing prominence; and the system was doomed when Berzelius felt obliged to withdraw this class of bodies from the general scheme, and place them by themselves in a special division, which he called the *haloids*. Then after a time it appeared that the simple oxides of the elements had neither acid nor basic properties in themselves, and only acquired active qualities of either kind when united with water; and that hydrogen and not oxygen was the acidifying principle. Moreover, multitudes of compounds were discovered in whose production oxygen took no part whatever, and, although attempts were made to classify these on the same general dualistic plan, assuming that sulphur, chlorine, or one of the allied elements might act in place of oxygen as a general binding agent in a chemical combination, yet the attempts were obvious failures.

Before I became a teacher of chemistry, in 1849, it had already become evident that Lavoisier's definition of a chemical element, as a substance that could not be decomposed, must be modified; or, at least, that even if our actual processes of analysis could not go beyond the substances regarded as elementary, the philosophy could not possibly be thus restricted. Many facts previously known but overlooked, and other facts then first discovered which exhibited the old facts in a stronger light, all combined to show clearly that the same chemical element might appear under the guise of different substances. By burning a gem in oxygen gas, Davy had proved that diamond was pure carbon; and when it was also shown that the iron in graphite was an accidental impurity, it appeared that carbon was known under three forms, dia-

mond, graphite, and charcoal. Sulphur, in like manner, was found to crystallize in two wholly incompatible forms, and under these different phases showing such marked differences of qualities that they must be regarded as distinct substances. In 1845 Schrötter proved that what had before been known as red phosphorus, and thought to be a lower oxide of the element, was in fact a different condition, an allotropic form, as it was then called, of pure phosphorus—a form which differs as widely from the wax-like, highly combustible material that is so well known as any two substances well could differ. A few years earlier Schönbein had discovered a new condition of oxygen, which he called *ozone*, differing widely from ordinary oxygen gas. Now, since all the forms of the same element yield the same products, and hence give the same chemical reactions, it became obvious, as such facts multiplied, that we may have different *substances* consisting wholly of the same chemical element; and hence that the chemical element, whatever it might be, could not be a definite substance, as Lavoisier had defined it.

Meanwhile another class of facts became prominent, chiefly in consequence of the investigations in organic chemistry to which Liebig had given such great impulse in Germany. Groups of compounds, consisting for the most part of carbon, hydrogen, and oxygen, came to be known, which, although having exactly the same composition (that is, formed by the union of the same elements in the same definite proportions), had, nevertheless, utterly different properties and relations. Such compounds are said to be isomeric, and a good example may be found in acetic ether, a very fragrant neutral spirit, and butyric acid, whose offensive odor and acrid taste are only too well known in rancid butter. But if oxygen is the acidifying principle of butyric acid, why does it not produce the same effect as an equal constituent of the ether? Similar phenomena of isomerism soon became very prominent, and forced on chemists the conviction, often against their prejudices, that the nature of the product depended not solely on the nature and proportions of the elements which entered into its composition, but quite as much, and even more, on the manner in which the constituents were combined.

To this phrase—the manner in which the constituents are combined—no definite meaning was at first attached; but the old atomic theory, first applied in chemistry by Dalton, was soon so modified as to give a form to the conception, and on the distinction between atoms and molecules then introduced the whole philosophy of modern chemistry rests.

In the subdivisions of material bodies, the molecules are the smallest masses in which the qualities of a substance inhere. A molecule of sugar or salt is simply a very small lump of sugar or

salt in which all the qualities of sweetness or saltness are preserved. These molecules, however, although the elements of substances, are not the ultimate elements of matter, but on the contrary are themselves aggregates—often very complex aggregates—of still smaller units which are considered to be the elemental atoms. Of such atoms we must admit as many different kinds as we have distinguished chemical elements, and the atoms are for the present the ultimate limit of our analysis of matter. These atoms are now the ideal chemical elements. Starting from the atoms, the orders of combination are, first, the union of the atoms to form the molecules which are the nuclei of definite substances, then the aggregation of these molecules to form material masses.

Obviously we may conceive of the union of either similar or of dissimilar atoms; and while the union of unlike atoms results in the production of molecules of compound substances, the union of like atoms (all of oxygen or all of hydrogen, for example) yields molecules of elementary substances. So far as the primary structure is concerned, there is no distinction between an elementary substance like oxygen gas and a compound substance like water. In each case the material is an aggregate of similar molecules, and owes its physical qualities to the external relations of its peculiar units; but, while the molecules of oxygen gas are each composed of two atoms of oxygen, the molecules of water consist each of two atoms of hydrogen and one of oxygen.

In admitting the possibility of the union of similar atoms to form the molecules of elementary substances, the new philosophy of chemistry differs most markedly from the old. The system of Lavoisier was based on a conception of dualism originally suggested by sexual relations; and the term *elective affinity*, which was so constantly used to explain chemical changes, was a phase of this conception. The elements of two kinds paired together to form acids or bases, and the acids and bases paired to form salts, and chemical changes were the consequence of the superior affinity of another acid or another base for the temporary mate of a fellow-companion. At the time of Lavoisier, the grosser features of these dualistic conceptions, which so disgust us in the earlier writers on chemistry, had disappeared; and, still later, Berzelius attempted to place the system on a scientific basis by referring the dualism to electrical relations. But there was an entire continuity of thought from first to last, and in this was involved the prevailing idea that strength of chemical union depended on opposition of qualities. But this idea, which I have no doubt many scholars who studied chemistry under the old system still retain, was an entire misconception.

One of the strongest combining forces known to chemistry is that which holds together the dissimilar atoms of oxygen and

hydrogen in the molecules of water, and, measured by the heat evolved, this force is nearly equaled by the force which unites the similar atoms of nitrogen to form a molecule of nitrogen gas; and the great violence of many modern explosives depends upon this circumstance.

It will now be seen that with our new philosophy the whole glamour which formerly bedazzled our idea of an elementary substance, and distinguished it widely from all other substances, disappears. The differences between substances depend upon the differences between their molecules, and as great molecular differences may arise from the union of similar as from the union of dissimilar atoms. The union of two atoms of hydrogen and one of oxygen gives a molecule of water, the union of two atoms of hydrogen and two of oxygen gives a molecule of peroxide of hydrogen; the union of two atoms of oxygen alone gives a molecule of oxygen gas, the union of three atoms of oxygen a molecule of ozone, and the difference between the last two substances is as great and of the same sort as the difference between the first two; and so it is with the so-called allotropic states of other elementary substances.

According to the modern philosophy of chemistry, the properties and relations of a substance depend fully as much upon the manner in which the atoms are grouped in the molecules of the substance as upon the nature of the atoms of which the molecules consist; and the differences between isomeric substances to which we have referred, depend wholly on what we call the molecular structure. The molecules, both of butyric acid and of acetic ether, consist of four atoms of carbon, eight atoms of hydrogen, and two of oxygen, and the chemist will show you just how these atoms are grouped in the molecule of each substance, and how the separate relations of these widely differing products depend on the structure he has assigned to their respective molecules. Indeed, the study of molecular structure—that is, of the mode of grouping of atoms in the molecules, especially in those of the compounds of carbon—has almost engrossed the attention of chemists for the past twenty-five years. An immense mass of facts and theories has been collected, and a symbolical method of representing the structure has been adopted, which, although highly conventional, must embody real truth, however dimly it may be now perceived; for the system has led to more, and more important, discoveries than any one of the dominant systems of science of the present day. The system has a great charm for students, and what is called the study of organic chemistry in our colleges is wholly a discussion of problems of this kind.

These systems of atoms that we call molecules have been frequently compared to the solar system, and cited as evidence that

man occupies an intermediate position in creation, with a microcosmos beneath as far removed from the order of his perceptions as is the macrocosmos above him. To one who realizes what must be the complex dynamical relations as well as the order of magnitude of these molecular systems, the diagrams of molecular structure which may be seen in any work on organic chemistry can not but appear as crude and childish as the figures of constellations on a celestial globe; and when, as frequently happens, the student confounds the sign and the substance, one can hardly refrain from a little good-natured laugh at the spider-leg formulæ, as a noted German chemist is in the habit of calling them. Still, these are only the conventional forms of a good working theory, which is a noble product of human thought and an effective means of advancing knowledge.

For one who has followed the history of chemical thought from the first, it is easy to discover great imperfections in our present system. The assumption that, with more than seventy different kinds of atoms already known, uniting in such varied combinations to form molecules, only like molecules should ever aggregate to form material masses, is a solecism in the very postulates of the system; and the whole question of molecular combination is one which is still in abeyance. Analogy forbids us to believe that, down to a certain limit of dimensions that we call molecules, the constitution of matter is of a wholly different sort from that which appears on subdividing the molecules. It is an equally incredible assumption that all atoms of the same element are so many independent creations exactly alike in every respect. Then, as our knowledge increases, the distinctions between the chemical elements are becoming less marked and their relations to each other more intimate. They are beginning to appear, not as isolated units, but as links in a complex network, which presents an unbroken continuity throughout. The recent study of the rarer earths leaves us in doubt whether we have an indefinite number of elements, or only one under unnumbered manifestations; and the later results of spectrum analysis seem to indicate quite clearly that, at the high temperatures of the sun and of the fixed stars, many of our terrestrial elements are decomposed. From a mathematical analysis of the spectra, Grünwald maintains—and supports his conclusion by a great array of confirmatory measurements—that the remarkable solar spectrum line called helium, and the equally well-marked line of the sun's corona, come from two constituents of hydrogen gas, the first of which is somewhat heavier and the last far lighter than hydrogen gas; and this conclusion, if not finally accepted, is regarded as highly probable by men of such scientific sobriety as Liveing and Dewar, of Cambridge, in England—men who are acknowledged as among

the best authorities on spectrum analysis. I had intended, in this connection, to discuss these last points, to which I can here only allude, and which are every day acquiring greater and greater importance; but my paper is already too long, and there is abundant material for another essay on the same general subject. I have accomplished the immediate object at which I aimed, if I have made evident that the foundations of our science are still hidden in obscurity, and that the conception of a chemical element is to-day just as indefinite and just as metaphysical as it was at the time of Aristotle.

AGNOSTICISM.

By Prof. THOMAS H. HUXLEY.

WITHIN the last few months the public has received much and varied information on the subject of agnostics, their tenets, and even their future. Agnosticism exercised the orators of the Church Congress at Manchester.* It has been furnished with a set of "articles" fewer, but not less rigid, and certainly not less consistent than the thirty-nine; its nature has been analyzed, and its future severely predicted by the most eloquent of that prophetical school whose Samuel is Auguste Comte. It may still be a question, however, whether the public is as much the wiser as might be expected, considering all the trouble that has been taken to enlighten it. Not only are the three accounts of the agnostic position sadly out of harmony with one another, but I propose to show cause for my belief that all three must be seriously questioned by any one who employs the term "agnostic" in the sense in which it was originally used. The learned principal of King's College, who brought the topic of agnosticism before the Church Congress, took a short and easy way of settling the business:

> But if this be so, for a man to urge, as an escape from this article of belief, that he has no means of a scientific knowledge of the unseen world, or of the future, is irrelevant. His difference from Christians lies not in the fact that he has no knowledge of these things, but that he does not believe the authority on which they are stated. He may prefer to call himself an agnostic; but his real name is an older one—he is an infidel; that is to say, an unbeliever. The word infidel, perhaps, carries an unpleasant significance. Perhaps it is right that it should. It is, and it ought to be, an unpleasant thing for a man to have to say plainly that he does not believe in Jesus Christ.

And in the course of the discussion which followed, the Bishop of

* See the "Official Report of the Church Congress held at Manchester," October, 1888, pp. 253, 254.

Peterborough departed so far from his customary courtesy and self-respect as to speak of "cowardly agnosticism" (p. 262).

So much of Dr. Wace's address either explicitly or implicitly concerns me, that I take upon myself to deal with it; but, in so doing, it must be understood that I speak for myself alone; I am not aware that there is any sect of Agnostics; and if there be, I am not its acknowledged prophet or pope. I desire to leave to the Comtists the entire monopoly of the manufacture of imitation ecclesiasticism.

Let us calmly and dispassionately consider Dr. Wace's appreciation of agnosticism. The agnostic, according to his view, is a person who says he has no means of attaining a scientific knowledge of the unseen world or of the future; by which somewhat loose phraseology Dr. Wace presumably means the theological unseen world and future. I can not think this description happy either in form or substance, but for the present it may pass. Dr. Wace continues, that is not "his difference from Christians." Are there, then, any Christians who say that they know nothing about the unseen world and the future? I was ignorant of the fact, but I am ready to accept it on the authority of a professional theologian, and I proceed to Dr. Wace's next proposition.

The real state of the case, then, is that the agnostic "does not believe the authority" on which "these things" are stated, which authority is Jesus Christ. He is simply an old-fashioned "infidel" who is afraid to own to his right name. As "Presbyter is priest writ large," so is "agnostic" the mere Greek equivalent for the Latin "infidel." There is an attractive simplicity about this solution of the problem; and it has that advantage of being somewhat offensive to the persons attacked, which is so dear to the less refined sort of controversialist. The agnostic says, "I can not find good evidence that so and so is true." "Ah," says his adversary, seizing his opportunity, "then you declare that Jesus Christ was untruthful, for he said so and so"; a very telling method of rousing prejudice. But suppose that the value of the evidence as to what Jesus may have said and done, and as to the exact nature and scope of his authority, is just that which the agnostic finds it most difficult to determine? If I venture to doubt that the Duke of Wellington gave the command, "Up, Guards, and at 'em!" at Waterloo, I do not think that even Dr. Wace would accuse me of disbelieving the duke. Yet it would be just as reasonable to do this as to accuse any one of denying what Jesus said before the preliminary question as to what he did say is settled.

Now, the question as to what Jesus really said and did is strictly a scientific problem, which is capable of solution by no other methods than those practiced by the historian and the literary critic. It is a problem of immense difficulty, which has

occupied some of the best heads in Europe for the last century; and it is only of late years that their investigations have begun to converge toward one conclusion.*

That kind of faith which Dr. Wace describes and lauds is of no use here. Indeed, he himself takes pains to destroy its evidential value.

"What made the Mohammedan world? Trust and faith in the declarations and assurances of Mohammed. And what made the Christian world? Trust and faith in the declarations and assurances of Jesus Christ and his apostles" (*loc. cit.*, p. 253). The triumphant tone of this imaginary catechism leads me to suspect that its author has hardly appreciated its full import. Presumably, Dr. Wace regards Mohammed as an unbeliever, or, to use the term which he prefers, infidel; and considers that his assurances have given rise to a vast delusion, which has led, and is leading, millions of men straight to everlasting punishment. And this being so, the "trust and faith" which have "made the Mohammedan world," in just the same sense as they have "made the Christian world," must be trust and faith in falsehood. No man who has studied history, or even attended to the occurrences of every-day life, can doubt the enormous practical value of trust and faith; but as little will he be inclined to deny that this practical value has not the least relation to the reality of the objects of that trust and faith. In examples of patient constancy of faith and of unswerving trust, the "Acta Martyrum" do not excel the annals of Babism.

The discussion upon which we have now entered goes so thoroughly to the root of the whole matter; the question of the day is so completely, as the author of "Robert Elsmere" says, the value of testimony, that I shall offer no apology for following it out somewhat in detail; and, by way of giving substance to the argument, I shall base what I have to say upon a case, the consideration of which lies strictly within the province of natural science, and of that particular part of it known as the physiology and pathology of the nervous system.

* Dr. Wace tells us, "It may be asked how far we can rely on the accounts we possess of our Lord's teaching on these subjects." And he seems to think the question appropriately answered by the assertion that it "ought to be regarded as settled by M. Renan's practical surrender of the adverse case." I thought I knew M. Renan's works pretty well, but I have contrived to miss this "practical" (I wish Dr. Wace had defined the scope of that useful adjective) surrender. However, as Dr. Wace can find no difficulty in pointing out the passage of M. Renan's writings, by which he feels justified in making his statement, I shall wait for further enlightenment, contenting myself, for the present, with remarking that if M. Renan were to retract and do penance in Notre Dame to-morrow for any contributions to Biblical criticism that may be specially his property, the main results of that criticism, as they are set forth in the works of Strauss, Baur, Reuss, and Volkmar, for example, would not be sensibly affected.

I find, in the second Gospel (chap. v), a statement, to all appearance intended to have the same evidential value as any other contained in that history. It is the well-known story of the devils who were cast out of a man, and ordered, or permitted, to enter into a herd of swine, to the great loss and damage of the innocent Gerasene, or Gadarene, pig-owners. There can be no doubt that the narrator intends to convey to his readers his own conviction that this casting out and entering in were effected by the agency of Jesus of Nazareth; that, by speech and action, Jesus enforced this conviction; nor does any inkling of the legal and moral difficulties of the case manifest itself.

On the other hand, everything that I know of physiological and pathological science leads me to entertain a very strong conviction that the phenomena ascribed to possession are as purely natural as those which constitute small-pox; everything that I know of anthropology leads me to think that the belief in demons and demoniacal possession is a mere survival of a once universal superstition, and that its persistence at the present time is pretty much in the inverse ratio of the general instruction, intelligence, and sound judgment of the population among whom it prevails. Everything that I know of law and justice convinces me that the wanton destruction of other people's property is a misdemeanor of evil example. Again, the study of history, and especially of that of the fifteenth, sixteenth, and seventeenth centuries, leaves no shadow of doubt on my mind that the belief in the reality of possession and of witchcraft, justly based, alike by Catholics and Protestants, upon this and innumerable other passages in both the Old and New Testaments, gave rise, through the special influence of Christian ecclesiastics, to the most horrible persecutions and judicial murders of thousands upon thousands of innocent men, women, and children. And when I reflect that the record of a plain and simple declaration upon such an occasion as this, that the belief in witchcraft and possession is wicked nonsense, would have rendered the long agony of mediæval humanity impossible, I am prompted to reject, as dishonoring, the supposition that such declaration was withheld out of condescension to popular error.

"Come forth, thou unclean spirit, out of the man" (Mark v, 8),* are the words attributed to Jesus. If I declare, as I have no hesitation in doing, that I utterly disbelieve in the existence of "unclean spirits," and, consequently, in the possibility of their "coming forth" out of a man, I suppose that Dr. Wace will tell me I am disregarding the "testimony of our Lord" (*loc. cit.*, p. 255). For if these words were really used, the most resourceful of reconcilers can hardly venture to affirm that they are compatible with

* Here, as always, the revised version is cited.

a disbelief in "these things." As the learned and fair-minded, as well as orthodox, Dr. Alexander remarks, in an editorial note to the article "Demoniacs," in the "Biblical Cyclopædia" (vol. i, p. 664, note):

> . . . . On the lowest grounds on which our Lord and his apostles can be placed, they must, at least, be regarded as *honest* men. Now, though honest speech does not require that words should be used always and only in their etymological sense, it does require that they should not be used so as to affirm what the speaker knows to be false. While, therefore, our Lord and his apostles might use the word δαιμονίζεσθαι, or the phrase δαιμόνιον ἔχειν, as a popular description of certain diseases, without giving in to the belief which lay at the source of such a mode of expression, they could not speak of demons entering into a man, or being cast out of him, without pledging themselves to the belief of an actual possession of the man by the demons (Campbell, "Prel. Diss.," vi, 1, 10). If, consequently, they did not hold this belief, they spoke not as honest men.

The story which we are considering does not rest on the authority of the second Gospel alone. The third confirms the second, especially in the matter of commanding the unclean spirit to come out of the man (Luke viii, 29); and, although the first Gospel either gives a different version of the same story, or tells another of like kind, the essential point remains: "If thou cast us out, send us away into the herd of swine. And he said unto them, Go!" (Matthew viii, 31, 32).

If the concurrent testimony of the three synoptics, then, is really sufficient to do away with all rational doubt as to a matter of fact of the utmost practical and speculative importance—belief or disbelief in which may affect, and has affected, men's lives and their conduct toward other men in the most serious way—then I am bound to believe that Jesus implicitly affirmed himself to possess a "knowledge of the unseen world," which afforded full confirmation to the belief in demons and possession current among his contemporaries. If the story is true, the mediæval theory of the invisible world may be, and probably is, quite correct; and the witch-finders, from Sprenger to Hopkins and Mather, are much-maligned men.

On the other hand, humanity, noting the frightful consequences of this belief; common sense, observing the futility of the evidence on which it is based, in all cases that have been properly investigated; science, more and more seeing its way to inclose all the phenomena of so-called "possession" within the domain of pathology, so far as they are not to be relegated to that of the police—all these powerful influences concur in warning us, at our peril, against accepting the belief without the most careful scrutiny of the authority on which it rests.

I can discern no escape from this dilemma: either Jesus said what he is reported to have said, or he did not. In the former

case, it is inevitable that his authority on matters connected with the "unseen world" should be roughly shaken; in the latter, the blow falls upon the authority of the synoptic gospels. If their report on a matter of such stupendous and far-reaching practical import as this is untrustworthy, how can we be sure of its trustworthiness in other cases? The favorite "earth," in which the hard-pressed reconciler takes refuge, that the Bible does not profess to teach science,* is stopped in this instance. For the question of the existence of demons and of possession by them, though it lies strictly within the province of science, is also of the deepest moral and religious significance. If physical and mental disorders are caused by demons, Gregory of Tours and his contemporaries rightly considered that relics and exorcists were more useful than doctors; the gravest questions arise as to the legal and moral responsibilities of persons inspired by demoniacal impulses; and our whole conception of the universe and of our relations to it becomes totally different from what it would be on the contrary hypothesis.

The theory of life of an average mediæval Christian was as different from that of an average nineteenth-century Englishman as that of a West-African negro is now in these respects. The modern world is slowly, but surely, shaking off these and other monstrous survivals of savage delusions, and, whatever happens, it will not return to that wallowing in the mire. Until the contrary is proved, I venture to doubt whether, at this present moment, any Protestant theologian, who has a reputation to lose, will say that he believes the Gadarene story.

The choice then lies between discrediting those who compiled the gospel biographies and disbelieving the Master, whom they, simple souls, thought to honor by preserving such traditions of the exercise of his authority over Satan's invisible world. This is the dilemma. No deep scholarship, nothing but a knowledge of the revised version (on which it is to be supposed all that mere scholarship can do has been done), with the application thereto of the commonest canons of common sense, is needful to enable us to make a choice between its horns. It is hardly doubtful that the

* Does any one really mean to say that there is any internal or external criterion by which the reader of a biblical statement, in which scientific matter is contained, is enabled to judge whether it is to be taken *au sérieux* or not? Is the account of the Deluge, accepted as true in the New Testament, less precise and specific than that of the call of Abraham, also accepted as true therein? By what mark does the story of the feeding with manna in the wilderness, which involves some very curious scientific problems, show that it is meant merely for edification, while the story of the inscription of the law on stone by the hand of Jahveh is literally true? If the story of the Fall is not the true record of an historical occurrence, what becomes of Pauline theology? Yet the story of the Fall as directly conflicts with probability, and is as devoid of trustworthy evidence, as that of the Creation or that of the Deluge, with which it forms an harmoniously legendary series.

story, as told in the first Gospel, is merely a version of that told in the second and third. Nevertheless, the discrepancies are serious and irreconcilable; and, on this ground alone, a suspension of judgment, at the least, is called for. But there is a great deal more to be said. From the dawn of scientific biblical criticism until the present day the evidence against the long-cherished notion that the three synoptic gospels are the works of three independent authors, each prompted by divine inspiration, has steadily accumulated, until, at the present time, there is no visible escape from the conclusion that each of the three is a compilation consisting of a groundwork common to all three—the threefold tradition; and of a superstructure, consisting, firstly, of matter common to it with one of the others, and, secondly, of matter special to each. The use of the terms "groundwork" and "superstructure" by no means implies that the latter must be of later date than the former. On the contrary, some parts of it may be, and probably are, older than some parts of the groundwork.*

The story of the Gadarene swine belongs to the groundwork; at least, the essential part of it, in which the belief in demoniac possession is expressed, does; and therefore the compilers of the first, second, and third gospels, whoever they were, certainly accepted that belief (which, indeed, was universal among both Jews and pagans at that time), and attributed it to Jesus.

What, then, do we know about the originator, or originators, of this groundwork—of that threefold tradition which all three witnesses (in Paley's phrase) agree upon—that we should allow their mere statements to outweigh the counter-arguments of humanity, of common sense, of exact science, and to imperil the respect which all would be glad to be able to render to their Master?

Absolutely nothing.† There is no proof, nothing more than a fair presumption, that any one of the gospels existed, in the state in which we find it in the authorized version of the Bible, before the second century, or, in other words, sixty or seventy years after the events recorded. And, between that time and the date of the oldest extant manuscripts of the Gospels, there is no telling what additions and alterations and interpolations may have been made. It may be said that this is all mere speculation, but it is a good

* See, for an admirable discussion of the whole subject, Dr. Abbott's article on the Gospels in the "Encyclopædia Britannica"; and the remarkable monograph by Prof. Volkmar, "Jesus Nazarenus und die erste christliche Zeit" (1882). Whether we agree with the conclusions of these writers or not, the method of critical investigation which they adopt is unimpeachable.

† Notwithstanding the hard words shot at me from behind the hedge of anonymity by a writer in a recent number of the "Quarterly Review," I repeat, without the slightest fear of refutation, that the four Gospels, as they have come to us, are the work of unknown writers.

deal more. As competent scholars and honest men, our revisers have felt compelled to point out that such things have happened even since the date of the oldest known manuscripts. The oldest two copies of the second Gospel end with the eighth verse of the sixteenth chapter; the remaining twelve verses are spurious, and it is noteworthy that the maker of the addition has not hesitated to introduce a speech in which Jesus promises his disciples that "in my name shall they cast out devils."

The other passage "rejected to the margin" is still more instructive. It is that touching apologue, with its profound ethical sense, of the woman taken in adultery—which, if internal evidence were an infallible guide, might well be affirmed to be a typical example of the teachings of Jesus. Yet, say the revisers, pitilessly, "Most of the ancient authorities omit John vii, 53, viii, 11." Now, let any reasonable man ask himself this question: If, after an approximative settlement of the canon of the New Testament, and even later than the fourth and fifth centuries, literary fabricators had the skill and the audacity to make such additions and interpolations as these, what may they have done when no one had thought of a canon; when oral tradition, still unfixed, was regarded as more valuable than such written records as may have existed in the latter portion of the first century? Or, to take the other alternative, if those who gradually settled the canon did not know of the existence of the oldest codices which have come down to us; or if, knowing them, they rejected their authority, what is to be thought of their competency as critics of the text?

People who object to free criticism of the Christian Scriptures forget that they are what they are in virtue of very free criticism; unless the advocates of inspiration are prepared to affirm that the majority of influential ecclesiastics during several centuries were safeguarded against error. For, even granting that some books of the period were inspired, they were certainly few among many; and those who selected the canonical books, unless they themselves were also inspired, must be regarded in the light of mere critics, and, from the evidence they have left of their intellectual habits, very uncritical critics. When one thinks that such delicate questions as those involved fell into the hands of men like Papias (who believed in the famous millenarian grape story); of Irenæus with his "reasons" for the existence of only four Gospels; and of such calm and dispassionate judges as Tertullian, with his "*Credo quia impossibile*," the marvel is that the selection which constitutes our New Testament is as free as it is from obviously objectionable matter. The apocryphal Gospels certainly deserve to be apocryphal; but one may suspect that a little more critical discrimination would have enlarged the Apocrypha not inconsiderably.

At this point a very obvious objection arises and deserves full and candid consideration. It may be said that critical skepticism carried to the length suggested is historical pyrrhonism; that if we are to altogether discredit an ancient or a modern historian, because he has assumed fabulous matter to be true, it will be as well to give up paying any attention to history. It may be said, and with great justice, that Eginhard's "Life of Charlemagne" is none the less trustworthy because of the astounding revelation of credulity, of lack of judgment, and even of respect for the eighth commandment, which he has unconsciously made in the "History of the Translation of the Blessed Martyrs Marcellinus and Paul." Or, to go no further back than the last number of this review, surely that excellent lady, Miss Strickland, is not to be refused all credence because of the myth about the second James's remains, which she seems to have unconsciously invented.

Of course this is perfectly true. I am afraid there is no man alive whose witness could be accepted, if the condition precedent were proof that he had never invented and promulgated a myth. In the minds of all of us there are little places here and there, like the indistinguishable spots on a rock which give foothold to moss or stone-crop; on which, if the germ of a myth fall, it is certain to grow, without in the least degree affecting our accuracy or truthfulness elsewhere. Sir Walter Scott knew that he could not repeat a story without, as he said, "giving it a new hat and stick." Most of us differ from Sir Walter only in not knowing about this tendency of the mythopœic faculty to break out unnoticed. But it is also perfectly true that the mythopœic faculty is not equally active on all minds, nor in all regions and under all conditions of the same mind. David Hume was certainly not so liable to temptation as the Venerable Bede, or even as some recent historians who could be mentioned; and the most imaginative of debtors, if he owes five pounds, never makes an obligation to pay a hundred out of it. The rule of common sense is *prima facie* to trust a witness in all matters in which neither his self-interest, his passions, his prejudices, nor that love of the marvelous, which is inherent to a greater or less degree in all mankind, are strongly concerned; and, when they are involved, to require corroborative evidence in exact proportion to the contravention of probability by the thing testified.

Now, in the Gadarene affair, I do not think I am unreasonably skeptical if I say that the existence of demons who can be transferred from a man to a pig does thus contravene probability. Let me be perfectly candid. I admit I have no *a priori* objection to offer. There are physical things, such as *tæniæ* and *trichinæ*, which can be transferred from men to pigs, and *vice versa*, and which do undoubtedly produce most diabolical and deadly effects

on both. For anything I can absolutely prove to the contrary, there may be spiritual things capable of the same transmigration, with like effects. Moreover, I am bound to add that perfectly truthful persons, for whom I have the greatest respect, believe in stories about spirits of the present day, quite as improbable as that we are considering.

So I declare, as plainly as I can, that I am unable to show cause why these transferable devils should not exist; nor can I deny that, not merely the whole Roman Church, but many Wacean "infidels" of no mean repute, do honestly and firmly believe that the activity of such-like demonic beings is in full swing in this year of grace 1889.

Nevertheless, as good Bishop Butler says, "probability is the guide of life," and it seems to me that this is just one of the cases in which the canon of credibility and testimony, which I have ventured to lay down, has full force. So that, with the most entire respect for many (by no means for all) of our witnesses for the truth of demonology, ancient and modern, I conceive their evidence on this particular matter to be ridiculously insufficient to warrant their conclusion.*

After what has been said I do not think that any sensible man, unless he happen to be angry, will accuse me of "contradicting the Lord and his apostles" if I reiterate my total disbelief in the whole Gadarene story. But, if that story is discredited, all the other stories of demoniac possession fall under suspicion. And if the belief in demons and demoniac possession, which forms the somber background of the whole picture of primitive Christianity presented to us in the New Testament, is shaken, what is to be said, in any case, of the uncorroborated testimony of the Gospels with respect to "the unseen world"?

I am not aware that I have been influenced by any more bias in regard to the Gadarene story than I have been in dealing with other cases of like kind the investigation of which has interested me. I was brought up in the strictest school of evangelical orthodoxy; and, when I was old enough to think for myself, I started

* Their arguments, in the long run, are always reducible to one form. Otherwise trustworthy witnesses affirm that such and such events took place. These events are inexplicable, except the agency of "spirits" is admitted. Therefore "spirits" were the cause of the phenomena.

And the heads of the reply are always the same. Remember Goethe's aphorism: "Alles factische ist schon Theorie." Trustworthy witnesses are constantly deceived, or deceive themselves, in their interpretation of sensible phenomena. No one can prove that the sensible phenomena, in these cases, could be caused only by the agency of spirits; and there is abundant ground for believing that they may be produced in other ways.

Therefore, the utmost that can be reasonably asked for, on the evidence as it stands, is suspension of judgment. And, on the necessity for even that suspension, reasonable men may differ, according to their views of probability.

upon my journey of inquiry with little doubt about the general truth of what I had been taught; and with that feeling of the unpleasantness of being called an "infidel" which, we are told, is so right and proper. Near my journey's end, I find myself in a condition of something more than mere doubt about these matters.

In the course of other inquiries, I have had to do with fossil remains which looked quite plain at a distance, and became more and more indistinct as I tried to define their outline by close inspection. There was something there—something which, if I could win assurance about it, might mark a new epoch in the history of the earth; but, study as long as I might, certainty eluded my grasp. So has it been with me in my efforts to define the grand figure of Jesus as it lies in the primary strata of Christian literature. Is he the kindly, peaceful Christ depicted in the Catacombs? Or is he the stern judge who frowns above the altar of SS. Cosmas and Damianus? Or can he be rightly represented in the bleeding ascetic, broken down by physical pain, of too many mediæval pictures? Are we to accept the Jesus of the second, or the Jesus of the fourth Gospel, as the true Jesus? What did he really say and do; and how much that is attributed to him in speech and action is the embroidery of the various parties into which his followers tended to split themselves within twenty years of his death, when even the threefold tradition was only nascent?

If any one will answer these questions for me with something more to the point than feeble talk about the "cowardice of agnosticism," I shall be deeply his debtor. Unless and until they are satisfactorily answered, I say of agnosticism in this matter, "*J'y suis, et j'y reste.*"

But, as we have seen, it is asserted that I have no business to call myself an agnostic; that if I am not a Christian I am an infidel; and that I ought to call myself by that name of "unpleasant significance." Well, I do not care much what I am called by other people, and, if I had at my side all those who since the Christian era have been called infidels by other folks, I could not desire better company. If these are my ancestors, I prefer, with the old Frank, to be with them wherever they are. But there are several points in Dr. Wace's contention which must be eliminated before I can even think of undertaking to carry out his wishes. I must, for instance, know what a Christian is. Now what is a Christian? By whose authority is the signification of that term defined? Is there any doubt that the immediate followers of Jesus, the "sect of the Nazarenes," were strictly orthodox Jews, differing from other Jews not more than the Sadducees, the Pharisees, and the Essenes differed from one another; in fact, only in the belief that the Messiah, for whom the rest of

their nation waited, had come? Was not their chief, "James, the brother of the Lord," reverenced alike by Sadducee, Pharisee, and Nazarene? At the famous conference which, according to the Acts, took place at Jerusalem, does not James declare that "myriads" of Jews, who, by that time had become Nazarenes, were "all zealous for the law"? Was not the name of "Christian" first used to denote the converts to the doctrine promulgated by Paul and Barnabas at Antioch? Does the subsequent history of Christianity leave any doubt that, from this time forth, the "little rift within the lute," caused by the new teaching developed, if not inaugurated, at Antioch, grew wider and wider, until the two types of doctrine irreconcilably diverged? Did not the primitive Nazarenism or Ebionism develop into the Nazarenism, and Ebionism, and Elkasaitism of later ages, and finally die out in obscurity and condemnation as damnable heresy; while the younger doctrine throve and pushed out its shoots into that endless variety of sects, of which the three strongest survivors are the Roman and Greek Churches and modern Protestantism?

Singular state of things! If I were to profess the doctrine which was held by "James, the brother of the Lord," and by every one of the "myriads" of his followers and co-religionists in Jerusalem up to twenty or thirty years after the crucifixion (and one knows not how much later at Pella), I should be condemned with unanimity as an ebionizing heretic by the Roman, Greek, and Protestant Churches! And, probably, this hearty and unanimous condemnation of the creed held by those who were in the closest personal relation with their Lord is almost the only point upon which they would be cordially of one mind. On the other hand—though I hardly dare imagine such a thing—I very much fear that the "pillars" of the primitive Hierosolymitan Church would have considered Dr. Wace an infidel. No one can read the famous second chapter of Galatians and the book of Revelation without seeing how narrow was even Paul's escape from a similar fate. And, if ecclesiastical history is to be trusted, the thirty-nine articles, be they right or wrong, diverge from the primitive doctrine of the Nazarenes vastly more than even Pauline Christianity did.

But, further than this, I have great difficulty in assuring myself that even James, "the brother of the Lord," and his "myriads" of Nazarenes, properly represented the doctrines of their Master. For it is constantly asserted by our modern "pillars" that one of the chief features of the work of Jesus was the instauration of religion by the abolition of what our sticklers for articles and liturgies, with unconscious humor, call the narrow restrictions of the law. Yet, if James knew this, how could the bitter controversy with Paul have arisen; and why did one or

the other side not quote any of the various sayings of Jesus, recorded in the Gospels, which directly bear on the question—sometimes, apparently, in opposite directions?

So, if I am asked to call myself an "infidel," I reply, To what doctrine do you ask me to be faithful? Is it that contained in the Nicene and the Athanasian Creeds? My firm belief is that the Nazarenes, say of the year 40, headed by James, would have stopped their ears and thought worthy of stoning the audacious man who propounded it to them. Is it contained in the so-called Apostles' Creed? I am pretty sure that even that would have created a recalcitrant commotion at Pella in the year 70, among the Nazarenes of Jerusalem, who had fled from the soldiers of Titus. And yet if the unadulterated tradition of the teachings of "the Nazarene" were to be found anywhere, it surely should have been amid those not very aged disciples who may have heard them as they were delivered.

Therefore, however sorry I may be to be unable to demonstrate that, if necessary, I should not be afraid to call myself an "infidel," I can not do it, even to gratify the Bishop of Peterborough and Dr. Wace. And I would appeal to the bishop, whose native sense of humor is not the least marked of his many excellent gifts and virtues, whether asking a man to call himself an "infidel" is not rather a droll request. "Infidel" is a term of reproach, which Christians and Mohammedans, in their modesty, agree to apply to those who differ from them. If he had only thought of it, Dr. Wace might have used the term "miscreant," which, with the same etymological signification, has the advantage of being still more "unpleasant" to the persons to whom it is applied. But, in the name of all that is Hibernian, I ask the Bishop of Peterborough why should a man be expected to call himself a "miscreant" or an "infidel"? That St. Patrick "had two birthdays because he was a twin" is a reasonable and intelligible utterance beside that of the man who should declare himself to be an infidel on the ground of denying his own belief. It may be logically, if not ethically, defensible that a Christian should call a Mohammedan an infidel, and *vice versa;* but, on Dr. Wace's principles, both ought to call themselves infidels, because each applies that term to the other.

Now I am afraid that all the Mohammedan world would agree in reciprocating that appellation to Dr. Wace himself. I once visited the Hazar Mosque, the great university of Mohammedanism, in Cairo, in ignorance of the fact that I was unprovided with proper authority. A swarm of angry undergraduates, as I suppose I ought to call them, came buzzing about me and my guide; and, if I had known Arabic, I suspect that "dog of an infidel" would have been by no means the most "unpleasant" of the

epithets showered upon me, before I could explain and apologize for the mistake. If I had had the pleasure of Dr. Wace's company on that occasion, the undiscriminative followers of the Prophet would, I am afraid, have made no difference between us; not even if they had known that he was the head of an orthodox Christian seminary. And I have not the smallest doubt that even one of the learned mollahs, if his grave courtesy would have permitted him to say anything offensive to men of another mode of belief, would have told us that he wondered we did not find it "very unpleasant" to disbelieve in the Prophet of Islam.

From what precedes, I think it becomes sufficiently clear that Dr. Wace's account of the origin of the name of "Agnostic" is quite wrong. Indeed, I am bound to add that very slight effort to discover the truth would have convinced him that, as a matter of fact, the term arose otherwise. I am loath to go over an old story once more; but more than one object which I have in view will be served by telling it a little more fully than it has yet been told.

Looking back nearly fifty years, I see myself as a boy, whose education had been interrupted, and who, intellectually, was left, for some years, altogether to his own devices. At that time, I was a voracious and omnivorous reader; a dreamer and speculator of the first water, well endowed with that splendid courage in attacking any and every subject, which is the blessed compensation of youth and inexperience. Among the books and essays, on all sorts of topics from metaphysics to heraldry, which I read at this time, two left indelible impressions on my mind. One was Guizot's "History of Civilization," the other was Sir William Hamilton's essay "On the Philosophy of the Unconditioned," which I came upon, by chance, in an odd volume of the "Edinburgh Review." The latter was certainly strange reading for a boy, and I could not possibly have understood a great deal of it;* nevertheless, I devoured it with avidity, and it stamped upon my mind the strong conviction that, on even the most solemn and important of questions, men are apt to take cunning phrases for answers; and that the limitation of our faculties, in a great number of cases, renders real answers to such questions, not merely actually impossible, but theoretically inconceivable.

Philosophy and history having laid hold of me in this eccentric fashion, have never loosened their grip. I have no pretension to be an expert in either subject; but the turn for philosophical and historical reading, which rendered Hamilton and Guizot attractive to me, has not only filled many lawful leisure hours, and

* Yet I must somehow have laid hold of the pith of the matter, for, many years afterward, when Dean Mansell's Bampton lectures were published, it seemed to me I already knew all that this eminently agnostic thinker had to tell me.

still more sleepless ones, with the repose of changed mental occupation, but has not unfrequently disputed my proper work-time with my liege lady, Natural Science. In this way I have found it possible to cover a good deal of ground in the territory of philosophy; and all the more easily that I have never cared much about A's or B's opinions, but have rather sought to know what answer he had to give to the questions I had to put to him—that of the limitation of possible knowledge being the chief. The ordinary examiner, with his "State the views of So-and-so," would have floored me at any time. If he had said, "What do *you* think about any given problem?" I might have got on fairly well.

The reader who has had the patience to follow the enforced, but unwilling, egotism of this veritable history (especially if his studies have led him in the same direction), will now see why my mind steadily gravitated toward the conclusions of Hume and Kant, so well stated by the latter in a sentence, which I have quoted elsewhere:

"The greatest and perhaps the sole use of all philosophy of pure reason is, after all, merely negative, since it serves not as an organon for the enlargement [of knowledge], but as a discipline for its delimitation; and, instead of discovering truth, has only the modest merit of preventing error." *

When I reached intellectual maturity and began to ask myself whether I was an atheist, a theist, or a pantheist; a materialist or an idealist; a Christian or a freethinker—I found that the more I learned and reflected, the less ready was the answer; until, at last, I came to the conclusion that I had neither art nor part with any of these denominations, except the last. The one thing in which most of these good people were agreed was the one thing in which I differed from them. They were quite sure they had attained a certain "gnosis"—had, more or less successfully, solved the problem of existence; while I was quite sure I had not, and had a pretty strong conviction that the problem was insoluble. And, with Hume and Kant on my side, I could not think myself presumptuous in holding fast by that opinion. Like Dante—

> "Nel mezzo del cammin di nostra vita
> Mi ritrovai per una selva oscura," †

but, unlike Dante, I can not add—

> "Che la diritta via era smarrita." ‡

On the contrary, I had, and have, the firmest conviction that I never left the "*verace via*"—the straight road; and that this road

* "Kritik der reinen Vernunft." Edit. Hartenstein, p. 256.

† [In the midway of this our mortal life
I found me in a gloomy wood astray.]

‡ [Gone from the path direct.]

led nowhere else but into the dark depths of a wild and tangled forest. And though I have found leopards and lions in the path; though I have made abundant acquaintance with the hungry wolf, that with "privy paw devours apace and nothing said," as another great poet says of the ravening beast; and though no friendly specter has even yet offered his guidance, I was, and am, minded to go straight on, until I either come out on the other side of the wood, or find there is no other side to it—at least, none attainable by me.

This was my situation when I had the good fortune to find a place among the members of that remarkable confraternity of antagonists, long since deceased, but of green and pious memory, the Metaphysical Society. Every variety of philosophical and theological opinion was represented there, and expressed itself with entire openness; most of my colleagues were *-ists* of one sort or another; and, however kind and friendly they might be, I, the man without a rag of a label to cover himself with, could not fail to have some of the uneasy feelings which must have beset the historical fox when, after leaving the trap in which his tail remained, he presented himself to his normally elongated companions. So I took thought, and invented what I conceived to be the appropriate title of "agnostic." It came into my head as suggestively antithetic to the "gnostic" of Church history, who professed to know so much about the very things of which I was ignorant; and I took the earliest opportunity of parading it at our society, to show that I, too, had a tail, like the other foxes. To my great satisfaction, the term took; and when the "Spectator" had stood godfather to it, any suspicion in the minds of respectable people, that a knowledge of its parentage might have awakened, was, of course, completely lulled.

That is the history of the origin of the terms "agnostic" and "agnosticism"; and it will be observed that it does not quite agree with the confident assertion of the reverend Principal of King's College, that "the adoption of the term agnostic is only an attempt to shift the issue, and that it involves a mere evasion" in relation to the Church and Christianity.*

The last objection (I rejoice, as much as my readers must do, that it is the last) which I have to take to Dr. Wace's deliverance before the Church Congress arises, I am sorry to say, on a question of morality.

"It is, and it ought to be," authoritatively declares this official representative of Christian ethics, "an unpleasant thing for a man to have to say plainly that he does not believe in Jesus Christ" (*l. c.*, p. 254).

Whether it is so, depends, I imagine, a good deal on whether

* "Report of the Church Congress," Manchester, 1888, p. 252.

the man was brought up in a Christian household or not. I do not see why it should be "unpleasant" for a Mohammedan or a Buddhist to say so. But that "it ought to be" unpleasant for any man to say anything which he sincerely, and after due deliberation, believes, is, to my mind, a proposition of the most profoundly immoral character. I verily believe that the great good which has been effected in the world by Christianity has been largely counteracted by the pestilent doctrine on which all the churches have insisted, that honest disbelief in their more or less astonishing creeds is a moral offense, indeed a sin of the deepest dye, deserving and involving the same future retribution as murder and robbery. If we could only see, in one view, the torrents of hypocrisy and cruelty, the lies, the slaughter, the violations of every obligation of humanity, which have flowed from this source along the course of the history of Christian nations, our worst imaginations of hell would pale beside the vision.

A thousand times, no! It ought *not* to be unpleasant to say that which one honestly believes or disbelieves. That it so constantly is painful to do so, is quite enough obstacle to the progress of mankind in that most valuable of all qualities, honesty of word or of deed, without erecting a sad concomitant of human weakness into something to be admired and cherished. The bravest of soldiers often, and very naturally, "feel it unpleasant" to go into action; but a court-martial which did its duty would make short work of the officer who promulgated the doctrine that his men *ought* to feel their duty unpleasant.

I am very well aware, as I suppose most thoughtful people are in these times, that the process of breaking away from old beliefs is extremely unpleasant; and I am much disposed to think that the encouragement, the consolation, and the peace afforded to earnest believers in even the worst forms of Christianity are of great practical advantage to them. What deductions must be made from this gain on the score of the harm done to the citizen by the ascetic other-worldliness of logical Christianity; to the ruler, by the hatred, malice, and all uncharitableness of sectarian bigotry; to the legislator, by the spirit of exclusiveness and domination of those that count themselves pillars of orthodoxy; to the philosopher, by the restraints on the freedom of learning and teaching which every church exercises, when it is strong enough; to the conscientious soul, by the introspective hunting after sins of the mint and cummin type, the fear of theological error, and the overpowering terror of possible damnation, which have accompanied the churches like their shadow, I need not now consider; but they are assuredly not small. If agnostics lose heavily on the one side, they gain a good deal on the other. People who talk about the comforts of belief appear to forget its discomforts;

they ignore the fact that the Christianity of the churches is something more than faith in the ideal personality of Jesus, which they create for themselves, *plus* so much as can be carried into practice, without disorganizing civil society, of the maxims of the Sermon on the Mount. Trip in morals or in doctrine (especially in doctrine), without due repentance or retractation, or fail to get properly baptized before you die, and a *plébiscite* of the Christians of Europe, if they were true to their creeds, would affirm your everlasting damnation by an immense majority.

Preachers, orthodox and heterodox, din into our ears that the world can not get on without faith of some sort. There is a sense in which that is as eminently as obviously true; there is another, in which, in my judgment, it is as eminently as obviously false, and it seems to me that the hortatory, or pulpit, mind is apt to oscillate between the false and the true meanings, without being aware of the fact.

It is quite true that the ground of every one of our actions, and the validity of all our reasonings, rest upon the great act of faith, which leads us to take the experience of the past as a safe guide in our dealings with the present and the future. From the nature of ratiocination it is obvious that the axioms on which it is based can not be demonstrated by ratiocination. It is also a trite observation that, in the business of life, we constantly take the most serious action upon evidence of an utterly insufficient character. But it is surely plain that faith is not necessarily entitled to dispense with ratiocination because ratiocination can not dispense with faith as a starting-point; and that because we are often obliged, by the pressure of events, to act on very bad evidence, it does not follow that it is proper to act on such evidence when the pressure is absent.

The writer of the epistle to the Hebrews tells us that "faith is the assurance of things hoped for, the proving of things not seen." In the authorized version "substance" stands for "assurance," and "evidence" for "the proving." The question of the exact meaning of the two words, ὑπόστασις and ἔλεγχος, affords a fine field of discussion for the scholar and the metaphysician. But I fancy we shall be not far from the mark if we take the writer to have had in his mind the profound psychological truth that men constantly feel certain about things for which they strongly hope, but have no evidence, in the legal or logical sense of the word; and he calls this feeling "faith." I may have the most absolute faith that a friend has not committed the crime of which he is accused. In the early days of English history, if my friend could have obtained a few more compurgators of like robust faith, he would have been acquitted. At the present day, if I tendered myself as a witness on that score, the judge would tell me to stand

down, and the youngest barrister would smile at my simplicity. Miserable indeed is the man who has not such faith in some of his fellow-men—only less miserable than the man who allows himself to forget that such faith is not, strictly speaking, evidence; and when his faith is disappointed, as will happen now and again, turns Timon and blames the universe for his own blunders. And so, if a man can find a friend, the hypostasis of all his hopes, the mirror of his ethical ideal, in the Jesus of any, or all, of the Gospels, let him live by faith in that ideal. Who shall or can forbid him? But let him not delude himself with the notion that his faith is evidence of the objective reality of that in which he trusts. Such evidence is to be obtained only by the use of the methods of science, as applied to history and to literature, and it amounts at present to very little.

It appears that Mr. Gladstone, some time ago, asked Mr. Laing if he could draw up a short summary of the negative creed; a body of negative propositions, which have so far been adopted on the negative side as to be what the Apostles' and other accepted creeds are on the positive; and Mr. Laing at once kindly obliged Mr. Gladstone with the desired articles—eight of them.

If any one had preferred this request to me, I should have replied that, if he referred to agnostics, they have no creed; and, by the nature of the case, can not have any. Agnosticism, in fact, is not a creed, but a method, the essence of which lies in the rigorous application of a single principle. That principle is of great antiquity; it is as old as Socrates; as old as the writer who said, "Try all things, hold fast by that which is good"; it is the foundation of the Reformation, which simply illustrated the axiom that every man should be able to give a reason for the faith that is in him; it is the great principle of Descartes; it is the fundamental axiom of modern science. Positively the principle may be expressed: In matters of the intellect, follow your reason as far as it will take you, without regard to any other consideration. And negatively: In matters of the intellect, do not pretend that conclusions are certain which are not demonstrated or demonstrable. That I take to be the agnostic faith, which if a man keep whole and undefiled, he shall not be ashamed to look the universe in the face, whatever the future may have in store for him.

The results of the working out of the agnostic principle will vary according to individual knowledge and capacity, and according to the general condition of science. That which is unproved to-day may be proved, by the help of new discoveries, to-morrow. The only negative fixed points will be those negations which flow from the demonstrable limitation of our faculties. And the only

obligation accepted is to have the mind always open to conviction. Agnostics who never fail in carrying out their principles are, I am afraid, as rare as other people of whom the same consistency can be truthfully predicated. But, if you were to meet with such a phœnix and to tell him that you had discovered that two and two make five, he would patiently ask you to state your reasons for that conviction, and express his readiness to agree with you if he found them satisfactory. The apostolic injunction to "suffer fools gladly," should be the rule of life of a true agnostic. I am deeply conscious how far I myself fall short of this ideal, but it is my personal conception of what agnostics ought to be.

However, as I began by stating, I speak only for myself; and I do not dream of anathematizing and excommunicating Mr. Laing. But, when I consider his creed and compare it with the Athanasian, I think I have, on the whole, a clearer conception of the meaning of the latter. "Polarity," in Article viii, for example, is a word about which I heard a good deal in my youth, when "Naturphilosophie" was in fashion, and greatly did I suffer from it. For many years past, whenever I have met with "polarity" anywhere but in a discussion of some purely physical topic, such as magnetism, I have shut the book. Mr. Laing must excuse me if the force of habit was too much for me when I read his eighth article.

And now, what is to be said to Mr. Harrison's remarkable deliverance "On the future of agnosticism"?* I would that it were not my business to say anything, for I am afraid that I can say nothing which shall manifest my great personal respect for this able writer, and for the zeal and energy with which he ever and anon galvanizes the weakly frame of positivism until it looks more than ever like John Bunyan's Pope and Pagan rolled into one. There is a story often repeated, and I am afraid none the less mythical on that account, of a valiant and loud-voiced corporal, in command of two full privates, who, falling in with a regiment of the enemy in the dark, orders it to surrender under pain of instant annihilation by his force; and the enemy surrenders accordingly. I am always reminded of this tale when I read the positivist commands to the forces of Christianity and of Science; only the enemy show no more signs of intending to obey now than they have done any time these forty years.

The allocution under consideration has the papal flavor which is wont to hang about the utterances of the pontiffs of the Church of Comte. Mr. Harrison speaks with authority, and not as one of the common scribes of the period. He knows not only what

* "Fortnightly Review," January, 1889.

agnosticism is and how it has come about, but what will become of it. The agnostic is to content himself with being the precursor of the positivist. In his place, as a sort of navvy leveling the ground and cleansing it of such poor stuff as Christianity, he is a useful creature who deserves patting on the back, on condition that he does not venture beyond his last. But let not these scientific Sanballats presume that they are good enough to take part in the building of the Temple—they are mere Samaritans, doomed to die out in proportion as the Religion of Humanity is accepted by mankind. Well, if that is their fate, they have time to be cheerful. But let us hear Mr. Harrison's pronouncement of their doom:

"Agnosticism is a stage in the evolution of religion, an entirely negative stage, the point reached by physicists, a purely mental conclusion, with no relation to things social at all" (p. 154). I am quite dazed by this declaration. Are there, then, any "conclusions" that are not "purely mental"? Is there "no relation to things social" in "mental conclusions" which affect men's whole conception of life? Was that prince of agnostics, David Hume, particularly imbued with physical science? Supposing physical science to be non-existent, would not the agnostic principle, applied by the philologist and the historian, lead to exactly the same results? Is the modern more or less complete suspension of judgment as to the facts of the history of regal Rome, or the real origin of the Homeric poems, anything but agnosticism in history and in literature? And if so, how can agnosticism be the "mere negation of the physicist"?

"Agnosticism is a stage in the evolution of religion." No two people agree as to what is meant by the term "religion"; but if it means, as I think it ought to mean, simply the reverence and love for the ethical ideal, and the desire to realize that ideal in life, which every man ought to feel—then I say agnosticism has no more to do with it than it has to do with music or painting. If, on the other hand, Mr. Harrison, like most people, means by "religion" theology, then, in my judgment, agnosticism can be said to be a stage in its evolution, only as death may be said to be the final stage in the evolution of life.

When agnostic logic is simply one of the canons of thought, agnosticism, as a distinctive faith, will have spontaneously disappeared (p. 155).

I can but marvel that such sentences as this, and those already quoted, should have proceeded from Mr. Harrison's pen. Does he really mean to suggest that agnostics have a logic peculiar to themselves? Will he kindly help me out of my bewilderment when I try to think of "logic" being anything else than the canon (which, I believe, means rule) of thought? As to agnosticism being a dis-

tinctive faith, I have already shown that it can not possibly be anything of the kind; unless perfect faith in logic is distinctive of agnostics, which, after all, it may be.

Agnosticism as a religious philosophy *per se* rests on an almost total ignoring of history and social evolution (p. 152).

But neither *per se* nor *per aliud* has agnosticism (if I know anything about it) the least pretension to be a religious philosophy; so far from resting on ignorance of history, and that social evolution of which history is the account, it is and has been the inevitable result of the strict adherence to scientific methods by historical investigators. Our forefathers were quite confident about the existence of Romulus and Remus, of King Arthur, and of Hengst and Horsa. Most of us have become agnostics in regard to the reality of these worthies. It is a matter of notoriety, of which Mr. Harrison, who accuses us all so freely of ignoring history, should not be ignorant, that the critical process which has shattered the foundations of orthodox Christian doctrine owes its origin, not to the devotees of physical science, but, before all, to Richard Simon, the learned French Oratorian, just two hundred years ago. I can not find evidence that either Simon, or any one of the great scholars and critics of the eighteenth and nineteenth centuries who have continued Simon's work, had any particular acquaintance with physical science. I have already pointed out that Hume was independent of it. And certainly one of the most potent influences in the same direction, upon history in the present century, that of Grote, did not come from the physical side. Physical science, in fact, has had nothing directly to do with the criticism of the Gospels; it is wholly incompetent to furnish demonstrative evidence that any statement made in these histories is untrue. Indeed, modern physiology can find parallels in nature for events of apparently the most eminently supernatural kind recounted in some of those histories.

It is a comfort to hear, upon Mr. Harrison's authority, that the laws of physical nature show no signs of becoming "less definite, less consistent, or less popular as time goes on" (p. 154). How a law of nature is to become indefinite, or "inconsistent," passes my poor powers of imagination. But with universal suffrage and the coach-dog theory of premiership in full view; the theory, I mean, that the whole duty of a political chief is to look sharp for the way the social coach is driving, and then run in front and bark loud—as if being the leading noise-maker and guiding were the same things—it is truly satisfactory to me to know that the laws of nature are increasing in popularity. Looking at recent developments of the policy which is said to express the great heart of

the people, I have had my doubts of the fact; and my love for my fellow-countrymen has led me to reflect with dread on what will happen to them, if any of the laws of nature ever become so unpopular in their eyes as to be voted down by the transcendent authority of universal suffrage. If the legion of demons, before they set out on their journey in the swine, had had time to hold a meeting and to resolve unanimously, "That the law of gravitation is oppressive and ought to be repealed," I am afraid it would have made no sort of difference to the result, when their two thousand unwilling porters were once launched down the steep slopes of the fatal shore of Gennesaret.

> The question of the place of religion as an element of human nature, as a force of human society, its origin, analysis, and functions, has never been considered at all from an agnostic point of view (p. 152).

I doubt not that Mr. Harrison knows vastly more about history than I do; in fact, he tells the public that some of my friends and I have had no opportunity of occupying ourselves with that subject. I do not like to contradict any statement which Mr. Harrison makes on his own authority; only, if I may be true to my agnostic principles, I humbly ask how he has obtained assurance on this head. I do not profess to know anything about the range of Mr. Harrison's studies; but as he has thought it fitting to start the subject, I may venture to point out that, on the evidence adduced, it might be equally permissible to draw the conclusion that Mr. Harrison's absorbing labors as the *pontifex maximus* of the positivist religion have not allowed him to acquire that acquaintance with the methods and results of physical science, or with the history of philosophy, or of philological and historical criticism, which is essential to any one who desires to obtain a right understanding of agnosticism. Incompetence in philosophy, and in all branches of science except mathematics, is the well-known mental characteristic of the founder of Positivism. Faithfulness in disciples is an admirable quality in itself; the pity is that it not unfrequently leads to the imitation of the weaknesses as well as of the strength of the master. It is only such over-faithfulness which can account for a "strong mind really saturated with the historical sense" (p. 153) exhibiting the extraordinary forgetfulness of the historical fact of the existence of David Hume implied by the assertion that

> it would be difficult to name a single known agnostic who has given to history anything like the amount of thought and study which he brings to a knowledge of the physical world (p. 153).

Whoso calls to mind, what I may venture to term, the bright side of Christianity; that ideal of manhood, with its strength and its patience; its justice and its pity for human frailty; its help-

fulness, to the extremity of self-sacrifice; its ethical purity and nobility; which apostles have pictured, in which armies of martyrs have placed their unshakable faith, and whence obscure men and women, like Catherine of Sienna and John Knox, have derived the courage to rebuke popes and kings, is not likely to underrate the importance of the Christian faith as a factor in human history, or to doubt that if that faith should prove to be incompatible with our knowledge, or necessary want of knowledge, some other hypostasis of men's hopes, genuine enough and worthy enough to replace it, will arise. But that the incongruous mixture of bad science with eviscerated papistry, out of which Comte manufactured the positivist religion, will be the heir of the Christian ages, I have too much respect for the humanity of the future to believe. Charles II told his brother, "They will not kill me, James, to make you king." And if critical science is remorselessly destroying the historical foundations of the noblest ideal of humanity which mankind have yet worshiped, it is little likely to permit the pitiful reality to climb into the vacant shrine.

That a man should determine to devote himself to the service of humanity—including intellectual and moral self-culture under that name; that this should be, in the proper sense of the word, his religion—is not only an intelligible, but, I think, a laudable resolution. And I am greatly disposed to believe that it is the only religion which will prove itself to be unassailably acceptable so long as the human race endures. But when the positivist asks me to worship "Humanity"—that is to say, to adore the generalized conception of men as they ever have been and probably ever will be—I must reply that I could just as soon bow down and worship the generalized conception of a "wilderness of apes." Surely we are not going back to the days of paganism, when individual men were deified, and the hard good sense of a dying Vespasian could prompt the bitter jest, "*Ut puto Deus fio.*" No divinity doth hedge a modern man, be he even a sovereign ruler. Nor is there any one, except a municipal magistrate, who is officially declared worshipful. But if there is no spark of worship-worthy divinity in the individual twigs of humanity, whence comes that godlike splendor which the Moses of positivism fondly imagines to pervade the whole bush?

I know no study which is so unutterably saddening as that of the evolution of humanity, as it is set forth in the annals of history. Out of the darkness of prehistoric ages man emerges with the marks of his lowly origin strong upon him. He is a brute, only more intelligent than the other brutes; a blind prey to impulses, which as often as not lead him to destruction; a victim to endless illusions, which make his mental existence a terror and a

burden, and fill his physical life with barren toil and battle. He attains a certain degree of physical comfort, and develops a more or less workable theory of life, in such favorable situations as the plains of Mesopotamia or of Egypt, and then, for thousands and thousands of years, struggles with varying fortunes, attended by infinite wickedness, bloodshed, and misery, to maintain himself at this point against the greed and the ambition of his fellow-men. He makes a point of killing and otherwise persecuting all those who first try to get him to move on; and when he has moved on a step, foolishly confers *post-mortem* deification on his victims. He exactly repeats the process with all who want to move a step yet farther. And the best men of the best epochs are simply those who make the fewest blunders and commit the fewest sins.

That one should rejoice in the good man; forgive the bad man; and pity and help all men to the best of one's ability, is surely indisputable. It is the glory of Judaism and of Christianity to have proclaimed this truth, through all their aberrations. But the worship of a God who needs forgiveness and help, and deserves pity every hour of his existence, is no better than that of any other voluntarily selected fetich. The Emperor Julian's project was hopeful, in comparison with the prospects of the new anthropolatry.

When the historian of religion in the twentieth century is writing about the nineteenth, I foresee he will say something of this kind:

The most curious and instructive events in the religious history of the preceding century are the rise and progress of two new sects, called Mormons and Positivists. To the student who has carefully considered these remarkable phenomena nothing in the records of religious self-delusion can appear improbable.

The Mormons arose in the midst of the great Republic, which, though comparatively insignificant at that time, in territory as in the number of its citizens, was (as we know from the fragments of the speeches of its orators which have come down to us) no less remarkable for the native intelligence of its population, than for the wide extent of their information, owing to the activity of their publishers in diffusing all that they could invent, beg, borrow, or steal. Nor were they less noted for their perfect freedom from all restraints in thought or speech or deed; except, to be sure, the beneficent and wise influence of the majority exerted, in case of need, through an institution known as "tarring and feathering," the exact nature of which is now disputed.

There is a complete consensus of testimony that the founder of Mormonism, one Joseph Smith, was a low-minded, ignorant scamp, and that he stole the "Scriptures" which he propounded; not being clever enough to forge even such contemptible stuff as they

contain. Nevertheless he must have been a man of some force of character, for a considerable number of disciples soon gathered about him. In spite of repeated outbursts of popular hatred and violence—during one of which persecutions, Smith was brutally murdered—the Mormon body steadily increased, and became a flourishing community. But the Mormon practices being objectionable to the majority, they were, more than once, without any pretense of law, but by force of riot, arson, and murder, driven away from the land they had occupied. Harried by these persecutions, the Mormon body eventually committed itself to the tender mercies of a desert as barren as that of Sinai; and, after terrible sufferings and privations, reached the oasis of Utah. Here it grew and flourished, sending out missionaries to, and receiving converts from, all parts of Europe, sometimes to the number of 10,000 in a year; until in 1880, the rich and flourishing community numbered 110,000 souls in Utah alone, while there were probably 30,000 or 40,000 scattered abroad elsewhere. In the whole history of religions there is no more remarkable example of the power of faith; and, in this case, the founder of that faith was indubitably a most despicable creature. It is interesting to observe that the course taken by the great Republic and its citizens runs exactly parallel with that taken by the Roman Empire and its citizens toward the early Christians, except that the Romans had a certain legal excuse for their acts of violence, inasmuch as the Christian "sodalitia" were not licensed, and consequently were, *ipso facto*, illegal assemblages. Until, in the latter part of the nineteenth century, the United States Legislature decreed the illegality of polygamy, the Mormons were wholly within the law.

Nothing can present a greater contrast to all this than the history of the Positivists. This sect arose much about the same time as that of the Mormons, in the upper and most instructed stratum of the quick-witted, skeptical population of Paris. The founder, Auguste Comte, was a teacher of mathematics, but of no eminence in that department of knowledge, and with nothing but an amateur's acquaintance with physical, chemical, and biological science. His works are repulsive on account of the dull diffuseness of their style, and a certain air, as of a superior person, which characterizes them; but, nevertheless, they contain good things here and there. It would take too much space to reproduce in detail a system which proposes to regulate all human life by the promulgation of a gentile Leviticus. Suffice it to say that M. Comte may be described as a syncretic, who, like the gnostics of early Church history, attempted to combine the substance of imperfectly comprehended contemporary science with the form of Roman Christianity. It may be that this is the reason why his disciples were

so very angry with some obscure people called Agnostics, whose views, if we may judge by the accounts left in the works of a great positivist controversial writer, were very absurd.

To put the matter briefly, M. Comte, finding Christianity and Science at daggers drawn, seems to have said to Science: "You find Christianity rotten at the core, do you? Well, I will scoop out the inside of it." And to Romanism: "You find Science mere dry light—cold and bare. Well, I will put your shell over it, and so, as schoolboys make a specter out of a turnip and a tallow candle, behold the new religion of Humanity complete!"

Unfortunately, neither the Romanists nor the people who were something more than amateurs in science could be got to worship M. Comte's new idol properly. In the native country of Positivism, one distinguished man of letters and one of science, for a time, helped to make up a roomful of the faithful, but their love soon grew cold. In England, on the other hand, there appears to be little doubt that, in the ninth decade of the century, the multitude of disciples reached the grand total of several score. They had the advantage of the advocacy of one or two most eloquent and learned apostles, and, at any rate, the sympathy of several persons of light and leading—and, if they were not seen, they were heard all over the world. On the other hand, as a sect, they labored under the prodigious disadvantage of being refined, estimable people, living in the midst of the worn-out civilization of the Old World; where any one who had tried to persecute them, as the Mormons were persecuted, would have been instantly hanged. But the majority never dreamed of persecuting them; on the contrary, they were rather given to scold, and otherwise try the patience of, the majority.

The history of these sects in the closing years of the century is highly instructive. Mormonism . . .

But I find I have suddenly slipped off Mr. Harrison's tripod, which I had borrowed for the occasion. The fact is, I am not equal to the prophetical business, and ought not to have undertaken it.—*Nineteenth Century.*

SOMETHING, it appears, is to be said in favor of the theory that the earth has received and is receiving supplies of carbon from meteors and space. A meteor that was found at Youndegin, Western Australia, in 1854, contained carbon of a form resembling graphite, but harder, and occurring in cubic crystals, of which about a hundred were separated. Observations of geological strata indicate an increase of carbon in the crust of the earth since the earliest times, for the rocks of the older formations contain less of it than those of the carboniferous and succeeding ones. Dr. Sterry Hunt has attributed the additional supplies to carbonic-acid gas diffused in space, and holds that the supposition that our atmosphere ever contained the whole amount at once would involve the presence of more enormous quantities of it than we can reasonably admit.

DOMESTICATION OF THE BUFFALO.

By JOHN W. DAFOE.

ONE of the most striking results due to the building of transcontinental railroads is the approach to extinction of the buffalo. Its vast range once extended from Great Slave Lake to the northeastern provinces of Mexico, and in British territory from the Rockies to wooded highlands six hundred miles west of Hudson's Bay. In the United States, remains of buffaloes have been found west of the Rockies in Oregon, in the Great Salt Lake basin, and westward as far as the Sierra Nevada. Of the species *bison*, two well-defined varieties are known, the prairie and the wood or mountain buffalo. The latter, compared with the other, is larger, coarser-haired, straighter-horned, and excessively shy. This shyness, together with the protection its habitat of forest affords it, have preserved its numbers in larger proportion than those of its congener of the prairies. Although the buffalo is savage of aspect and strong of limb, yet it is much less formidable to a hunter than the so-called tame cattle of the Texan plains. It is an expert and fearless climber, and only a very swift horse can overtake it, yet its stupidity and lack of courage have had not a little to do with the sweeping destruction which has overtaken it. As long ago as 1825, Prof. Joel A. Allen tells us, in his valuable monograph, "The History of the American Bison," it had been exterminated throughout the whole region east of the Mississippi, except for a limited area lying around the sources of that river. This extermination was utterly wanton; buffalo-hunting was chiefly mere sport, and often the only portion of the carcass removed was the tongue, much esteemed as a tidbit. In gainful hunting, it was rarely the buffalo's meat that was sought; its robe was the object of its relentless pursuit. This pursuit was immensely facilitated by the Pacific Railroads, which at the same time opened up new markets both for robes and meat. Colonel H. I. Dodge, author of "The Plains of the Great West," estimates that, in the three years ending with 1874, no fewer than 5,500,000 buffaloes were slaughtered. Mr. Miller Christy, who carefully took a census of the species last year, finds their total number to be but 1,100 or thereabout. So wantonly have the buffaloes been slain that their very bones have become an article of commerce. Regina, the seat of the territorial government of the Canadian Northwest, is built on Pile-of-Bones Creek, so called from the vast accumulation which encumbered its banks. Throughout the whole Western prairie region the earth is pitted with buffalo-wallows, often deep enough to long survive cultivation. These

wallows are due to the instinct whereby the huge brute, with a quickness which would not be expected of it, can roll itself in loam until it has donned a garment impervious to flies, and which in falling away carries off loose hair. When only dry, dusty soil is available, the buffalo will roll in that, greatly to the prejudice of its insect parasites. Wallows thus formed, numerous enough to testify to the comparatively recent existence of vast herds, can be most easily seen about the time of sunrise or sunset, when the almost horizontal solar beams throw them into shadow. In years gone by it was not uncommon to find in the hot springs of the Yellowstone Park, and of Banff, in the Canadian National Park, the remains of a buffalo strayed from a herd to find death in a scalding basin. The reckless extirpation of the buffalo has been fraught with very serious consequences to Indian tribes north and south of the international boundary. One of their hardships, which has been the frequent source of complaint and rebellion, has been the deprivation of buffalo-meat which in large areas was the Indian's principal food. Scarcely less serious has been the like deprivation entailed upon pioneer settlers, whose sites have in many cases been indicated to them by the buffalo-trails. In their migrations between north and south, and in their search for herbage least covered with snow, the buffalo has ever marked out the best and most feasible path.

While, as in other departments of her great natural wealth, America has been prodigal and spendthrift, there have been several noteworthy attempts not only to stay the threatened extermination of the buffalo, but to multiply its numbers and improve the race by crossing it with domestic cattle. It is curious how far back experiments in this direction date. Peter Kalm, in his "Travels in North America," says that buffaloes were domesticated in Quebec in 1750, and that in Carolina they had been crossed with domestic cattle. So docile indeed was a buffalo bull mentioned in Schoolcraft's "History of the Indians of the United States," that he had been yoked to the plow. Robert Wickliffe, of Lexington, Ky., in 1843, wrote Audubon and Bachman that he had secured quarter, half, and three-quarter crosses between the buffalo and domestic cattle. The progeny were tame, worked in yoke, exceeded the ox in strength, and retained the wallowing habit. All the half-bred heifers were fertile, but the half-bred bulls were not. Colonel George C. Thompson, of Shawnee Springs, Ky., concurrently with Mr. Wickliffe's experiment, domesticated a buffalo bull and three buffalo cows; they were thoroughly docile, hardy, and long-lived. Mr. I. W. Cunningham, of Howard County, Neb., in 1878, recorded that both domestication and crossing had been successful in the county mentioned—just as in Mr. Wickliffe's case. However, with the horse as a competitor as a

draught-animal, and the ox and cow as their rivals in the production of beef and milk, buffaloes have not until recent years sufficiently risen in value to warrant their domestication and breeding being taken up systematically and on a large scale. It is their rapid approach to extinction that has made the man of business succeed to the curious experimenter of a decade or a century ago,

FIG. 1.—FULL-BLOOD BUFFALOES DOMESTICATED.

and recognize how much of value there is in a strain which, if opportunity be not promptly seized, will soon be no more than a remembrance. Regarding, then, the buffalo as an animal well worthy conserving, what are his good and bad points? First of all, he is hardy, not liable to disease, and on the plains of the American and Canadian Northwest he can forage in deep snow and live in the open air all winter long. His meat brings nearly as good a price as beef. His robe is worth $25 to $40; and his head taxidermized, thanks to the decorative tastes of sportsmen, fetches as much as the robe, or even more. So much for the credit side of the account; now for the debit. The buffalo is a strong brute, and of a temper at times so fierce that his domestication is a task not seldom accompanied by decided hazard. Ordinary fences are as gossamer to a buffalo bull, especially during the irritable years when he is past his prime and finds himself less attractive than of yore. Still, the example of well-behaved domestic cattle, with which buffaloes readily amalgamate, is very effective. It is not, however, in mere domestication, but in cross-breeding that the buffalo's value consists. In pairing a buffalo bull and domestic cow the young are brought forth without any unusual percentage of loss being sustained. The offspring combines good points of sire and dam. It has nearly all its sire's hardiness and strength, and so much of its dam's tractability as to be well suited for draught purposes. When killed, the net

weight of its carcass exceeds that of a buffalo's, while the meat is better. Such a carcass has been known to weigh as much as 1,100 pounds net. Its robe is much more valuable than the buffalo's; for its fur, instead of being chiefly bunched at the

FIG. 2.—THREE-QUARTER-BLOOD BUFFALOES. Cross between Buffalo Bull and Half-blood Buffalo Cow.

mane, is evenly distributed over the hide, and is much finer in quality—its present value being from $50 to $75. A buffalo crossed with a half-bred cow produces an animal quite as hardy as its sire, but not quite so large. Experiments of much interest are in progress with various strains of domestic cattle, the outcome promising to be perhaps only less important than the original domestication, and subsequent molding, of horses and cattle from their primitive wild forms.

Chief among the ranches where the domestication of the buffalo is taking place and its crosses are being bred is that of Mr. C. J. Jones, at Garden City, Kan. The nucleus of his herd, seven calves and fifteen adult buffaloes, were run down by him on the Texan plains, two to three hundred miles from Garden City. He has crossed Texan cows with buffalo bulls, and obtained excellent results. In November last he acquired a herd of eighty-three animals from Mr. Samuel L. Bedson, of Stony Mountain, sixteen miles from Winnipeg, the capital of Manitoba. The crosses in this herd were from Galloway or polled Angus cattle; they are much superior to those from Texan strains, and are presented in the accompanying illustrations. Mr. Bedson's herd dated from 1877, when he first corraled a buffalo bull and four heifers. These five animals were part of the small remnant grazing in the vast region between the Saskatchewan River and the international boundary, the region now traversed by the Canadian Pacific Railway. In that immense plain the slaughter of buffaloes, due to the traffic of the Hudson's Bay Company, had been for two

centuries much more active than that on American soil. In eleven years Mr. Bedson's herd increased from five to ninety-seven, fourteen of the number having been disposed of before the sale to Mr. Jones. Of the eighty-three which he bought, there are eight adult crosses, or grades as they are called, and seventeen calves of 1888, pure and grade. It is Mr. Jones's intention thor-

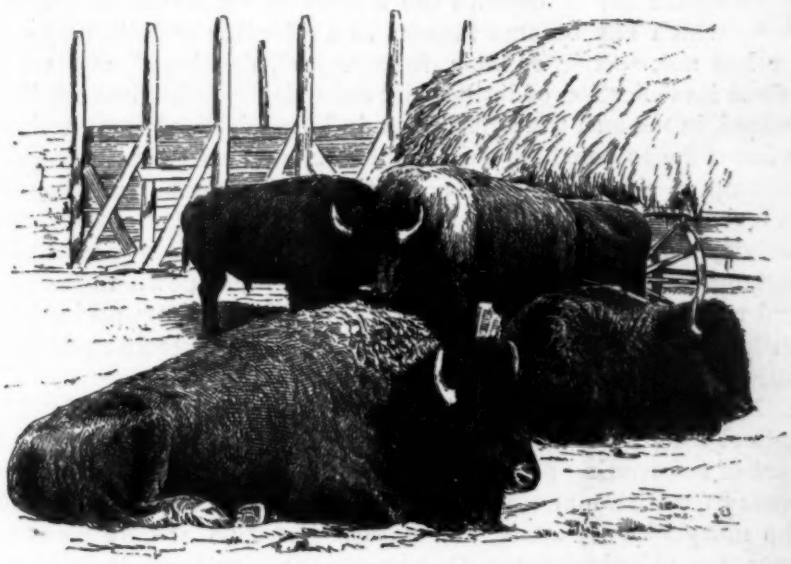

Fig. 3.—Half-Blood Buffaloes. Cross between Buffalo Bull and Domestic Cow.

oughly to test various strains with a view to ascertain which are best adapted for grazing herds on the plains of the Northwest. In producing a robe he has already attained what he calls a "seal-skin buffalo," from crossing with black cattle.

At Silver Heights, five miles from Winnipeg, Sir Donald Smith has a small herd of buffalo-crosses presenting unique points in beauty and docility. Elsewhere in Manitoba, in Alberta Territory, and in Minnesota, it is proposed to parallel Mr. Jones's enterprise of Garden City.

It has been suggested as an additional advantage of technical education that it will afford room for the cultivation of what may be called man's instinctive intelligence, for which hardly any provision is made in the present systems. "While the rational faculties and purely physical capabilities are elaborately cared for, practically nothing is done, save in the most casual and hap-hazard way, for improving the faculties which lie upon the border-land of instinct and reason," for the development of such powers, for example, as the exquisite adjustment and co-ordination that give the cricketer's skill in catching a passing ball, or the violinist's in eliciting a succession of enrapturing harmonies from his instrument. Genius can not be manufactured or conferred, but the average of the instinctive intelligence and facility might be greatly raised by well-directed training.

ZOÖLOGICAL GARDENS: THEIR USES AND MANAGEMENT.

By R. W. SHUFELDT, M. D., C. M. Z. S.

RARELY has it been in the history of the world that a city which has become famous as a scientific and literary center has not, sooner or later, inaugurated, developed, and maintained its collection of living wild animals, its zoölogical gardens. Indeed, in modern times, as of old, in large civilized communities, it has come to be where such establishments are in existence, and kept up to a high state of perfection and growth, that they are the very badge denoting the presence of marked intellectual activity along the lines we have indicated. With respect to the instances of this in history, they are too well known to the general reader to require enumeration here, while we are all familiar with the names of those cities of our own day wherein such institutions are now flourishing.

In modern times, again, the enormous impulse which the biological sciences have received, the far keener appreciation on the part of the reading public in such matters; and the pressing necessity for such material as zoölogical gardens can alone supply the morphologist, artist, and animal historian, are, we must believe, the principal forces that eventually give birth to these collections.

The uses of a zoölogical garden to a civilized country are manifold, and not easily to be overestimated. These uses are considerably enhanced if it is established within easy access of large biological museums and libraries. Sometimes it so happens, however, that in a large city where zoölogical gardens, museums, and libraries exist, the former may be situated several miles from the last two mentioned, and this is the misfortune to which we more particularly refer, and, if it can be avoided, should be by all means.

If properly conducted, a zoölogical garden sees its chief use in being a powerful auxiliary to those more general schemes undertaken on the part of the state for the benefit of the community at large, in which educational ends are to be met. And in the management of such a garden, everything connected with it should be continually bent in that direction; the managers should ever keep clearly before their minds this fact, that the principal object they have in view is an educational one—that they have under their control an engine capable of diffusing annually among the people an incalculable store of highly useful knowledge. The moment that such an institution sinks to the level of a purpose-

lessly arranged and heterogeneously selected collection of animals, the throngs that stream through the garden grounds will resort there as curiosity-seekers, and will lose sight of the idea that they are in a place and enjoying an atmosphere of culture, refinement, and education. History goes to show that the superb zoölogical gardens now maintained in London were first opened in 1828, since which time, down to 1887, twenty-four million five hundred and seventy-two thousand four hundred and five visitors were entered upon the register-books of the management. An instant's reflection will be sufficient to convince any friend of education of the benefits that humanity has derived hence, and of the refining influences which have through this center alone been brought into play.

Extensive zoölogical gardens, in addition, open to the masses a long chapter on the life-histories of the animals of their own country, as well as those of foreign lands. Then by the proper methods it becomes easy to bring the visitor face to face with other questions intimately associated with the animals themselves: I refer to their geographical ranges; the physical aspect of the countries they inhabit; and, finally, through the library and lecture system, something about their natural history and structure.

People are by such means enabled to supplement their readings and studies by having the very objects brought before them. At a glance, the striking differences between the Asiatic and African elephants are appreciated through the eye. One soon becomes familiar with the various forms of our American deer, and has a better realizing sense of the fact that the elk resort to the mountain fastnesses as their normal haunts, while our antelope rarely quit the plains. From school-days up, the American youth, by such means, gains a knowledge of the forms of the magnificent representatives of the various faunæ of his land, in comparison with which the illustrations in the text-book, although not to be altogether despised, are inadequate.

Here the sculptor, artist, and engraver can, at their leisure, study the noblest of animal forms under the most advantageous of circumstances. Leopards and pumas may be caught in the very act of a high-noon *siesta*, or perchance in some short and fiery quarrel, showing all the lineaments of anger characteristic of their race when aroused. Ornithologists may catch for their folios the transitory tints of the glowing plumages of trogons and toucans as they disport themselves in their large, airy cages, in a manner to be achieved under no other conditions. Then, by the aid of camera, brush, and pencil, tints and forms are brought to the eye and hand of the sculptor and engraver, which in time take on material shape in bronze and stone, and the ideas pass into art and design, and thus culture is the gainer in the end.

It is here, again, that a thousand facts each year are brought directly under the observation of the naturalist and specialist in every department of biology—nidification in all its details among birds; all the data in connection with the breeding habits of mammals; and a volume of unwritten lore having reference to the life-histories of our native reptiles and their kin.

Nor is this all, for it is at the zoölogical garden that the morphologist, surrounded as he there is by all the conveniences that civilization can bring, finds that priceless opportunity to carry on his researches upon the structure of animals, in ways that he could not do under any other circumstances; for material is here brought before him that, as a rule, not only admits of the investigation of individual forms, but from its abundance enables him, like Garrod in London, to draw conclusions from the anatomy presented by whole natural groups, and thus science is an enormous gainer.

It will be seen, then, from what has gone before, that not only are great pleasure and enjoyment of a highly elevating character brought to thousands of people annually, who have the opportunity of frequenting a large zoölogical garden, but those ultimate ends of all human activities—education, culture, art, and science—are immensely benefited thereby; and this implies a powerful and constant operation of a good influence for all mankind.

When a city distinguished as being a scientific center, or mayhap the national capital—and this itself may be such a city—determines upon establishing a zoölogical garden within its precincts, a great deal depends upon the site which is chosen for the purpose.

If possible, the form of the grounds should be a regular figure, an oblong being one of the best, with a long side toward the direction whence come the prevailing winds, as this assists in securing good ventilation; and the area should include at least two hundred to two hundred and fifty acres. The site should be within some convenient distance of the city museums and libraries; surely not separated from these by more than three miles at the most. Another matter of great importance is the character of the country, which should be as diversified as possible; and the inclosure should contain a few sizable ponds or a good, strong stream of water, in which event the former can be easily constructed artificially. Old trees in groups; some low, level marshland; and some hills and rocky portions, are all points of extreme natural advantage. These latter features, if marked, usually insure, too, another benefit, for then hilly or broken country is likely to be found immediately beyond the limits of the garden, which, though conducive to the building of handsome suburban residences, is not likely to fill up entirely with houses as the city in-

creases in size; and thus excellent ventilation is secured for all time.

There are several highly important elements which should be paramount in the administration of the affairs of such an institution in order to insure its highest success and most healthy growth and usefulness. Chief among these is the matter of choice of the persons selected to constitute the staff of such a zoölogical garden as we have in mind. Next are the methods of confining and exhibiting the collection of animals of the place; the regulations controlling its sanitation and keeping; and provision of those steps which lead to the public and special workers deriving the greatest amount of benefit from it, in a purely educational point of view, incorporating here the subservience of Science in her diverse ends and means.

In the spring of this year (1888), the Zoölogical Society of London, in addition to its regular staff of officers, employed the following persons: one superintendent, one assistant superintendent, one head keeper, six keepers (first class), ten keepers (second class), eight keepers (third class), three money-takers, one storekeeper, one cook, one office-clerk, one prosector's assistant, one head gardener, nineteen helpers in the menagerie, ten garden laborers, seven artisans, two painters, six laborers, one butcher, two firemen, two night watchmen, and one time-keeper—making a whole force of about eighty-five people, the duties of whom are sufficiently suggested by their designations. It is hardly necessary to say that the gentlemen composing the staff of officers should be selected not only for their executive ability in the departments they severally fill, but likewise for their distinction in some branch of zoölogical science, and more especially vertebrate zoology. Of that part of the staff which has just been enumerated above, especial regard should be paid to the selection of the keepers, who should be men fond of animals and their care, gentle and patient, and otherwise particularly fitted for their employment.

A great deal depends upon the various methods adopted of exhibiting the different mammals, birds, and reptiles in the collection, not only so far as the comfort of these is concerned, but the amount of instruction and benefit we derive from the several plans employed. For instance, it would hardly be considered advisable to keep specimens of the Rocky Mountain goat (*Mazama*) within an inclosure wherein the ground was a dead level, and specimens of the prong-horn antelope (*Antilocapra*) in another inclosure wherein a rocky hillock of some considerable dimensions might exist: for, in the first instance, the animal would not only be unhappy in his quarters, but would be made incapable of exhibiting a number of his natural traits; while a mass of rocks

in the antelope inclosure would be a waste of material, and take up room that the animals might otherwise enjoy.

Prof. Flower, the President of the London Zoölogical Society, in his address on the 16th of June, 1887, to the general meeting, made some excellent remarks upon this point when he said that "the old idea of keeping animals in small, cramped cages and dens, inherited from the Tower and traveling wild-beast shows, still lingers in many places. We have a responsibility to our captive animals, brought from their native wilds to minister to our pleasure and instruction, beyond that of merely supplying them with food and shelter. The more their comfort can be studied, and roomier their place of captivity, the more they are surrounded by conditions reproducing those of their native haunts, the happier they will be, and the more enjoyment and instruction we shall obtain when looking at them." Then continuing, and referring to the London gardens, he said: "Many of our newest improvements are markedly in this direction. I may especially mention the new inclosure for wild sheep near the lion-house in the South Garden, with its picturesque rock-work and fall of water, and the large aviary for herons and similar birds just completed on what used to be called the Water-Fowls' Lawn."

The writer is convinced of the truth of these words, from his own studies of zoölogical gardens in this country and abroad.

Again, to show the bad effects of the overcrowding of animals, Prof. Flower further observed, still confining himself to the London gardens: "The primary habitation of the lions and other large feline animals was the building on the north side of the tunnel, which many of us may remember as a reptile-house, and which has been lately restored as a dwelling-place for the smaller carnivora. The council reports of the period frequently speak of the bad accommodation it afforded to the inmates, the consequent injury to their health, and the disagreeable effects on visitors from the closeness of the atmosphere. In September, 1843, the terrace, with its double row of cages beneath, was completed; and the report of the following spring, speaking of this as 'one of the most important works ever undertaken at the gardens,' congratulates the society upon the fact that the anticipations of the increased health of this interesting portion of the collection, resulting from a free exposure to the external air and total absence of artificial heat, had been fully realized. The effects of more air and greater exercise were indeed said to have become visible almost immediately. Animals which were emaciated and sickly before their removal became plump and sleek in a fortnight after, and the appetites of all were so materially increased that they began to kill and eat each other. This, however, led to an immediate increase in their allowance of food, since

which time, it is stated, no further accidents of the kind have occurred."

Very often, when birds are kept in cramped quarters, they can not be induced to show off any of their peculiar habits, much less take to breeding. This was well seen in the case of the herons a year or so ago in the London gardens; for, as soon as these birds were transferred from their limited confines to the large new aviary constructed for them, and inclosing natural waters, trees, and shrubs, they resumed at once some of their more natural habits, while the ibises built in the trees and reared their young. Some mammals and birds bear confinement in narrow habitations better than others; and one can easily imagine that a sloth would tolerate a curtailment of his liberties far better than many species of monkeys would do, or some varieties of parrots than the freedom-loving sea-fowl.

At the Bishop's Gardens in Havana, Cuba, I remember very well a large aviary, in which were confined a considerable number of wild ducks, sea-gulls, and similar birds, and it was a delight to watch them, as they appeared to be fully as contented as in their native wilds, and would sport in the inclosed sheet of water, or preen themselves on the rocks, all day long. Then, some creatures bear being continually looked at better than others, while some have such highly nervous organizations that they should be placed only in the more secluded nooks of the garden, and even then have the means of withdrawing from the public gaze for at least a time. As owls never outgrow their fondness for a hollow stump, bears their climbing-poles, parrots their swing-boughs, and musk-rats their marsh-ways, we should make every endeavor to bring all our ingenuity to our aid in imitating as closely as possible in the gardens their natural conditions. The writer has during his lifetime kept a great many animals in confinement, of all manner of varieties, from a pocket gopher to an eagle, and from a ring-tailed howler-monkey to a turkey-buzzard, and has learned that, notwithstanding the creature may be abundantly supplied with his proper food, you can kill a star-nosed mole if you do not give him the opportunity to burrow in moist, wet ground; or render a porcupine utterly miserable if you do not serve him with the stump of an old tree, some ten feet above the ground, to stretch himself out upon.

Experience has taught us that the best way of exhibiting almost all kinds of reptiles, from the largest varieties of snakes and pythons down to the most diminutive species of lizards and hylas, is in that style of cage wherein the front and sides are formed of large single panes of clear glass. This allows an excellent view of the inmates, and full opportunity to watch and study their habits. On the other hand, the alligators, as representatives of

this class, do best in a sluggish pool, with marshy banks, and with flat, mossy rocks and logs to bask themselves upon. Out at West End, in New Orleans, there is a small place of this kind, and the several large alligators I saw in it seemed to be as well contented as though they were enjoying the peculiar advantages of their native bayous; and, as common as these great reptiles are in Louisiana, those at West End always seemed to have more or fewer people intently watching them; and sometimes, even in the broiling noonday sun, one might see one of the oldest and most aristocratic residents of Royal Street stop there for a passing moment, just to "take a glance at the 'gators."

Throughout the garden the names of all the animals should be made known to the visitors by the managers seeing to it that the cages or other receptacles confining them are properly though not too conspicuously labeled. An excellent form of label is a small, water-tight, cast-iron, and painted one, with a glass-slide front. In this the white paper slip may be kept, upon which in plain black letters is printed the name of the animal—that is, its most common name—with its accepted technical name; and a brief statement giving sex and normal geographical range in nature.

However amusing it may be, it also has its other aspects, to see a party of some ten or a dozen people standing before a large tank-cage containing a pair of fur-seals, and, from the absence of a label, not a soul able to divine the name of the creatures contained in it; and perhaps, too, one or more ladies in the group with a seal sack on.

In a country like the United States, where a number of its finest mammals and some birds are rapidly becoming extinct, it devolves as a solemn duty upon the management of a zoölogical garden to secure a goodly representation of these for permanent preservation. Among the mammals which now need such action none is better known than the buffalo, though the Rocky Mountain goat (*Mazama*), the beaver, and several species of deer stand in the same case; indeed, I presume the day will come to this country when all of our larger mammals will cease to exist in a state of nature, and we shall have to depend upon our gardens and parks for examples of them. Of the birds, our Carolina parrot and roseate spoonbill are conspicuous examples, and it can be only a few years at most when both species will be extinct in this country.

Animals in a zoölogical garden should be grouped, so far as circumstances will admit, into their natural orders of the class to which they belong. For instance, all the dogs, wolves, and foxes, and their nearest allies, should be made to inhabit a den or dens in the same part of the garden, and in all cases special means

should be adopted to point out the animals belonging to the country in which the garden is maintained. The system of labeling will do much toward this if carried out as suggested on a previous page; and if keepers and others are intelligent and obliging, as they surely should be, they can accomplish a great deal in a few words to groups of inquiring visitors.

Many questions touching upon special details in administration—as the best means to be adopted to secure desirable acquisitions to the garden, to the methods of exchange, of contracts for food, and similar matters, and whether or not it is desirable to make a small charge to visitors as an entrance-fee—hardly fall within the scope of the present article to discuss.

Modern architecture and artisanship, and present-day knowledge of sanitary engineering and sanitation, with our ever-increasing literature upon the diseases and their treatment in the lower animals, all leave but little to be desired for a superintendent of a zoölogical garden to draw upon for the application of their principles to the institution under his charge. If means be ample, there is not the shadow of excuse why such a place may not be made as inviting as the "gardens of the gods," and cleanliness and purity completely carried out.

One main building always constitutes an inseparable part of a model zoölogical garden, and it is devoted to the offices and study-rooms of the staff, to the lecture-room, to the reading-room and library, to the photographic gallery, to the laboratories and store-rooms, and, finally, to a few spare rooms for special purposes.

The lecture-room should be properly fitted up, and made to accommodate a large audience. Here, at certain seasons, a course of free lectures should be delivered on some branch of zoölogy or zoötomy, either by some resident member of the staff, or by specialists.

No well-appointed zoölogical building in connection with a garden would be complete without its reading-room and library. In the latter should be found, in time, all the standard works that have appeared upon the various branches of natural science, and more particularly upon vertebrate zoölogy and morphology, including, of course, such subjects as classification and geographical distribution of animals, and the reports of other zoölogical gardens and societies. On the reading-tables should appear the various authoritative zoölogical periodicals of the day, and bound volumes of the same should be upon the library shelves. It is an excellent idea to have the walls of such a room as this hung with strong relief maps of the various parts of the world, upon which are portrayed by clear defining lines the several regions as they are described by zoögraphers, showing the natural geographical distribution of animals. Within these areas there might be

printed the names of the best-known representatives of the vertebrate kingdom that distinguish them. Such a series of maps or charts would be highly instructive to the visitor, useful at times in the lecture-room, and always a convenience to others.

Few departments will be more important than the photographic gallery, and it should be under the charge of a thoroughly competent photographer, who should also combine in his knowledge a familiarity with the habits of animals, and what is required of him through his art. He can be kept constantly at work photographing the rarer animals. Efforts should be constantly made to catch them in the act of any of their peculiar habits; pictures should be made of their young at all stages, the appearance of the dams at the various periods of gestation, the nesting of the various species of birds, and so on indefinitely. Further, he should be enabled to take photographs of special dissections of the prosector, and of casts and skeletons, and similar work. A full series of these photographs should be bound and kept on file in the collections of the establishment, as they will be of the very highest importance to the scientific taxidermist, artist, engraver, zoölogist, and others.

From one cause or another, a certain proportion of the animals die every year; and in the year 1887, in the London Gardens, for example, there were added twenty-five hundred and twenty-five animals of the three classes of vertebrates—quadrupeds, birds, and reptiles; and during the same year nine hundred and twenty-five died. Now, these dead animals are in the majority of cases of inestimable value, and no such material should ever be allowed to go to waste. It should come immediately under the charge of the prosector, so he may promptly direct what use is to be made of it. As a rule, it is not desirable for the garden to accumulate an anatomical collection, though it is highly useful for the prosector to have on hand preparations of certain forms; but, in the main, large skeletons or bodies of animals should be turned over to the city museums. In the case of duplicates, or where animals have died and their anatomical structure has been previously described, they may sometimes be sold or exchanged for living animals, or otherwise disposed of. Often small species can be at once consigned to alcohol, for the future use of the prosectorial department. Rare forms that are but slightly known morphologically should be thoroughly described and figured, either by the prosector or by special workers to whom such material may be sent for the purpose. These descriptions and figures should constitute the main feature of the published reports of the garden, and they should be got out in a style as handsome as printer and engraver can make them, and bound in a manner compatible with their importance and value. They will not make up, how-

ever, the entire quarterly report, as in it also will appear the engravings and descriptions of hitherto unfigured animals, and a general account of the quarterly proceedings of the entire establishment, and other matters of interest.

Thus it will be seen that the prosectorial department is one of the most important connected with the institution, and in due time will contribute to the common stock of scientific knowledge a mass of information of a peculiarly valuable character, and of a kind, as a rule, not easily obtainable in any other way.

Taken, then, in its entirety, a zoölogical garden, such as I have attempted to outline in this paper, has within its means to powerfully aid, encourage, and stimulate human progress, education, and science in an infinite variety of ways; and such an institution stands among the very best of investments to be made either on the part of State or city. Here are library, lecture, art, design, and interest for the multitude, and yet how rarely does it occur to the mind of the philanthropist to make an endowment in such a direction! Moneys diverted into such channels not only are given to the cause of education and learning and art, but to the embellishment of the city where the garden is founded, to the interest of its people, and the perpetuation of the name of the donor. Zoölogical gardens, again, even exert a far more powerful influence toward luring those of certain classes and conditions away from the vices of a city than does the museum or the library; while, with others, it leads to a greater interest and appreciation of the other establishments and their advantages.

With respect to a nation as a whole that has arrived at a certain height of civilization, and can boast of a well-filled treasury, it almost, if not quite, becomes her bounden duty to her people, and to the common good, to endow such an institution at her national capital, in connection with other scientific departments, of which she is the supporter in chief. And it should be the pride of every intelligent citizen of such a nation to see to it, as far as he is individually able, that the capital of his country is not backward in such matters, especially when he comes to look about him and sees that the most distinguished and influential nations of the earth are characterized by possessing just such institutions at the seat of their national governments.

THE International Geological Congress map of northern Germany, which is in proof, is to be printed in twenty-four different tints for the sedimentary formations, three for the archæan, and nine for the eruptive rocks, and will consist of forty-nine sheets. One color is taken for each group—Cretaceous, green; Jurassic, blue, etc. The subdivisions are shown by various modifications of these colors. As a rule, the lower subdivisions are shown by the darker tints.

THE DERIVATIVE ORIGIN OF THE HUMAN MIND.*

By G. J. ROMANES, F. R. S.

IF it is true that "the proper study of mankind is man," assuredly the study of nature has never before reached a territory of thought so important in all its aspects as that which in our own generation it is for the first time approaching. After centuries of intellectual conquest in all regions of the phenomenal universe, man has at last begun to find that he may apply in a new and most unexpected manner the adage of antiquity—*Know thyself.* For he has begun to perceive a strong probability, if not an actual certainty, that his own living nature is identical in kind with the nature of all other life, and that even the most amazing side of this his own nature—nay, the most amazing of all things within the reach of his knowledge—the human mind itself, is but the topmost inflorescence of one mighty growth, whose roots and stem and many branches are sunk in the abyss of planetary time. Therefore, with Prof. Huxley we may say: "The importance of such an inquiry is indeed intuitively manifest. Brought face to face with these blurred copies of himself, the least thoughtful of men is conscious of a certain shock, due perhaps not so much to disgust at the aspect of what looks like an insulting caricature, as to the awaking of a sudden and profound mistrust of time-honored theories and strongly rooted prejudices regarding his own position in nature, and his relations to the wider world of life; while that which remains a dim suspicion for the unthinking, becomes a vast argument, fraught with the deepest consequences, for all who are acquainted with the recent progress of anatomical and physiological sciences." †

The problem, then, which in this generation has for the first time been presented to human thought, is the problem of how this thought itself has come to be. A question of the deepest importance to every system of philosophy has been raised by the study of biology; and it is the question whether the mind of man is essentially the same as the mind of the lower animals, or, having had, either wholly or in part, some other mode of origin, is essentially distinct—differing not only in degree but in kind from all other types of psychical being. And forasmuch as upon this great and deeply interesting question opinions are still much divided—even among those most eminent in the walks of science who agree in accepting the principles of evolution as applied to explain the mental constitution of the lower animals—it is evident that the

* From "Mental Evolution in Man." By George John Romanes, LL. D., F. R. S. New York: D. Appleton & Co., 1889.

† "Man's Place in Nature," p. 59.

question is neither a superficial nor an easy one. I shall, however, endeavor to examine it with as little obscurity as possible, and also, I need hardly say, with all the impartiality of which I am capable.*

It will be remembered that in the introductory chapter of my previous work† I have already briefly sketched the manner in which I propose to treat this question. Here, therefore, it is sufficient to remark that I began by assuming the truth of the general theory of descent so far as the animal kingdom is concerned, both with respect to bodily and to mental organization; but in doing this I expressly excluded the mental organization of man, as being a department of comparative psychology with reference to which I did not feel entitled to assume the principles of evolution. The reason why I made this special exception, I sufficiently explained; and I shall therefore now proceed, without further introduction, to a full consideration of the problem that is before us.

First, let us consider the question on purely *a priori* grounds. In accordance with our original hypothesis—upon which all naturalists of any standing are nowadays agreed—the process of organic and of mental evolution has been continuous throughout the whole region of life and of mind, with the one exception of the mind of man. On grounds of analogy, therefore, we should deem it antecedently improbable that the process of evolution, elsewhere so uniform and ubiquitous, should have been interrupted at its terminal phase. And looking to the very large extent of this analogy, the antecedent presumption which it raises is so considerable, that in my opinion it could only be counterbalanced by some very cogent and unmistakable facts, showing a difference between animal and human psychology so distinctive as to render it in the nature of the case virtually impossible that the one could ever have graduated into the other. This I posit as the first consideration.

Next, still restricting ourselves to an *a priori* view, it is unquestionable that human psychology, in the case of every individual human being, presents to actual observation a process of gradual development, or evolution, extending from infancy to manhood; and that in this process, which begins at a zero level of mental

* It is perhaps desirable to explain from the first that by the words "difference of kind," as used in the above paragraph and elsewhere throughout this treatise, I mean difference of *origin*. This is the only real distinction that can be drawn between the terms "difference of kind" and "difference of degree"; and I should scarcely have deemed it worth while to give the definition, had it not been for the confused manner in which the terms are used by some writers—e. g., Prof. Sayce, who says, while speaking of the development of languages from a common source, "differences of degree become in time differences of kind" ("Introduction to the Science of Language," ii, 309).

† "Mental Evolution in Animals."

life and may culminate in genius, there is nowhere and never observable a sudden leap of progress, such as the passage from one order of psychical being to another might reasonably be expected to show. Therefore, it is a matter of observable fact that, whether or not human intelligence differs from animal in kind, it certainly does admit of gradual development from a zero level. This I posit as the second consideration.

Again, so long as it is passing through the lower phases of its development, the human mind assuredly ascends through a scale of mental faculties which are parallel with those that are permanently presented by the psychological species of the animal kingdom. A glance at the accompanying diagram will serve to show in how strikingly quantitative, as well as qualitative, a manner the development of an individual human mind follows the order of mental evolution in the animal kingdom. And when we remember that, at all events up to the level where this parallel ends, the diagram is not an expression of any psychological theory, but of well-observed and undeniable psychological fact, I think every reasonable man must allow that, whatever the explanation of this remarkable coincidence may be, it certainly must admit of *some* explanation—i. e., can not be ascribed to mere chance. But, if so, the only explanation available is that which is furnished by the theory of descent. These facts, which I present as a third consideration, tend still further—and, I think, most strongly—to increase the force of antecedent presumption against any hypothesis which supposes that the process of evolution can have been discontinuous in the region of mind.

Lastly, it is likewise a matter of observation, as I shall fully show in the next installment of this work, that in the history of our race—as recorded in documents, traditions, antiquarian remains, and flint implements—the intelligence of the race has been subject to a steady process of gradual development. The force of this consideration lies in its proving that, if the process of mental evolution was suspended between the anthropoid apes and primitive man, it was again resumed with primitive man, and has since continued as uninterruptedly in the human species as it previously did in the animal species. Now, upon the face of these facts, or from a merely antecedent point of view, such appears to me, to say the least, a highly improbable supposition. At all events, it certainly is not the kind of supposition which men of science are disposed to regard with favor elsewhere; for a long and arduous experience has taught us that the most paying kind of supposition which we can bring with us into our study of nature, is that which recognizes in nature the principle of *continuity*.

Taking, then, these several *a priori* considerations together, they must, in my opinion, be fairly held to make out a very strong

prima facie case in favor of the view that there has been no interruption of the developmental process in the course of psychological history; but that the mind of man, like the mind of animals—and, indeed, like everything else in the domain of living nature—has been evolved. For these considerations show, not only that on analogical grounds any such interruption must be held as in itself improbable; but also that there is nothing in the constitution of the human mind incompatible with the supposition of its having been slowly evolved, seeing that not only in the case of every individual life, but also during the whole history of our species, the human mind actually *does* undergo, and *has* undergone, the process in question.

In order to overturn so immense a presumption as is thus erected on *a priori* grounds, the psychologist must fairly be called upon to supply some very powerful considerations of an *a posteriori* kind, tending to show that there is something in the constitution of the human mind which renders it virtually impossible—or at all events exceedingly difficult to imagine—that it can have proceeded by way of genetic descent from mind of lower orders. I shall therefore proceed to consider, as carefully and as impartially as I can, the arguments which have been adduced in support of this thesis.

In the introductory chapter of my previous work * I observed that the question whether or not human intelligence has been evolved from animal intelligence can only be dealt with scientifically by comparing the one with the other, in order to ascertain the points wherein they agree and the points wherein they differ. I shall, therefore, here begin by briefly stating the points of agreement, and then proceed more carefully to consider all the more important views which have hitherto been propounded concerning the points of difference.

If we have regard to emotions as these occur in the brute, we can not fail to be struck by the broad fact that the area of psychology which they cover is so nearly coextensive with that which is covered by the emotional faculties of man. In my previous works I have given what I consider unquestionable evidence of all the following emotions, which I here name in the order of their appearance through the psychological scale—fear, surprise, affection, pugnacity, curiosity, jealousy, anger, play, sympathy, emulation, pride, resentment, emotion of the beautiful, grief, hate, cruelty, benevolence, revenge, rage, shame, regret, deceitfulness, emotion of the ludicrous.†

Now, this list exhausts all the human emotions, with the exception of those which refer to religion, moral sense, and perception

* "Mental Evolution in Animals."

† See "Mental Evolution in Animals," chapter on the Emotions.

of the sublime. Therefore I think we are fully entitled to conclude that, so far as emotions are concerned, it can not be said that the facts of animal psychology raise any difficulties against the theory of descent. On the contrary, the emotional life of animals is so strikingly similar to the emotional life of man—and especially of young children—that I think the similarity ought fairly to be taken as direct evidence of a genetic continuity between them.

And so it is with regard to instinct. Understanding this term in the sense previously defined,* it is unquestionably true that in man—especially during the periods of infancy and youth—sundry well-marked instincts are presented, which have reference chiefly to nutrition, self-preservation, reproduction, and the rearing of progeny. No one has ventured to dispute that all these instincts are identical with those which we observe in the lower animals; nor, on the other hand, has any one ventured to suggest that there is any instinct which can be said to be peculiar to man, unless the moral and religious sentiments are taken to be of the nature of instincts. And although it is true that instinct plays a larger part in the psychology of many animals than it does in the psychology of man, this fact is plainly of no importance in the present connection, where we are concerned only with identity of principle. If any one were childish enough to argue that the mind of a man differs in kind from that of a brute because it does not display any particular instinct—such, for example, as the spinning of webs, the building of nests, or the incubation of eggs—the answer of course would be that, by parity of reasoning, the mind of a spider must be held to differ in kind from that of a bird. So far, then, as instincts and emotions are concerned, the parallel before us is much too close to admit of any argument on the opposite side.

With regard to volition more will be said in a future installment of this work. Here, therefore, it is enough to say, in general terms, that no one has seriously questioned the identity of kind between the animal and the human will, up to the point at which so-called freedom is supposed by some dissentients to supervene and characterize the latter. Now, of course, if the human will differs from the animal will in any important feature or attribute such as this, the fact must be duly taken into account during the course of our subsequent analysis. At present, however, we are only engaged upon a preliminary sketch of the points of resem-

* "Mental Evolution in Animals," p. 159. "The term is a generic one, comprising all the faculties of mind which are concerned in conscious and adaptive action, antecedent to individual experience, without necessary knowledge of the relation between means employed and ends attained, but similarly performed under similar and frequently recurring circumstances by all individuals of the same species."

	Products of Emotional Development.	
50		50
49		49
48		48
47		47
46		46
45		45
44		44
43		43
42		42
41		41
40		40
39		39
38		38
37		37
36		36
35		35
34		34
33		33
32		32
31		31
30		30
29		29
28	Shame, Remorse, Deceitfulness, Ludicrous.	28
27	Revenge, Rage.	27
26	Grief, Hate, Cruelty, Benevolence.	26
25	Emulation, Pride, Resentment, Æsthetic love of ornament, Terror.	25
24	Sympathy.	24
23		23
22	Affection.	22
21	Jealousy, Anger, Play.	21
20	Parental affection, Social feelings, Sexual selection, Pugnacity, Industry, Curiosity.	20
19	Sexual emotions without sexual selection.	19
18	Surprise, Fear.	18
17		17
16		16
15		15
14		14
13		13
12		12
11		11
10		10
9		9
8		8
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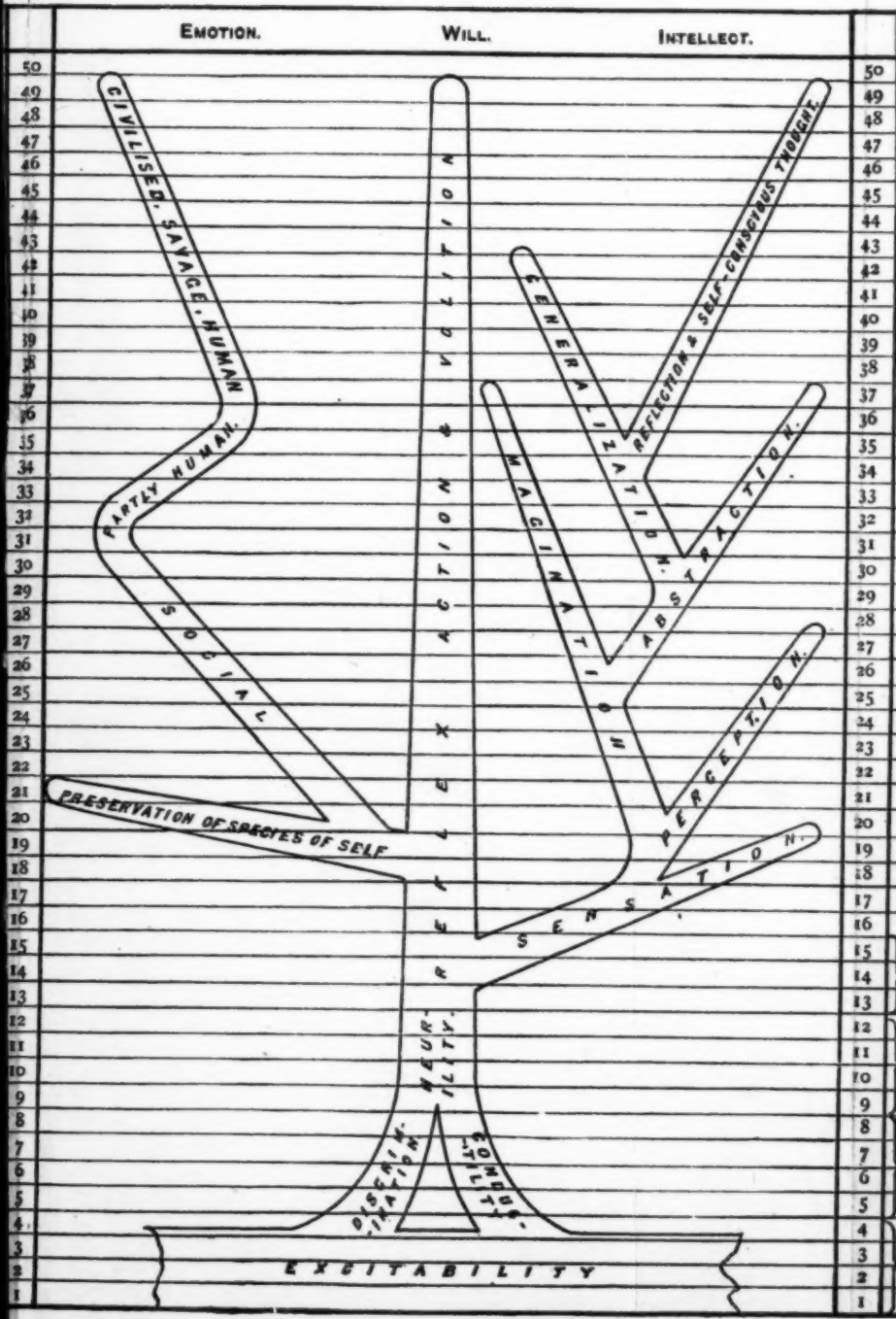
2		2
1		1

CIVILISED.
PARTLY
PRESERVAT


EMOTION.
WILL.
INTELLECT.
CIVILISED. SAVAGE. HUMAN
PARTLY HUMAN.
SOCIAL
PRESERVATION OF SPECIES OF SELF
VOLITION & ACTION
NEUROMUSCULAR EXCITABILITY
DISCRIMINATION
GENERALIZATION
REFLECTION & SELF-CONSCIOUS THOUGHT.
IMAGINATION
ABSTRACTION.
PERCEPTION.
SENSATION.
EXCITABILITY

		Products of Intellectual Development.	The Psychological Scale.	Psychogenesis of Man.	
	50				50
	49				49
	48				48
	47				47
	46				46
	45				45
	44				44
	43				43
	42				42
	41				41
	40				40
	39				39
	38				38
	37				37
	36				36
	35				35
	34				34
	33				33
	32				32
	31				31
	30				30
	29				29
	28	Indefinite morality.	Arthropoid Apes and Dog.	15 months.	28
	27	Use of tools.	Monkeys, and Elephant	12 months.	27
	26	Understanding of mechanisms.	Carnivora, Rodents, and Ruminants	10 months.	26
	25	Recognition of Pictures, Understanding of words, Dreaming.	Birds.	8 months.	25
	24	Communication of ideas.	Hymenoptera.	5 months.	24
	23	Recognition of persons.	Reptiles and Cephalopods.	4 months.	23
	22	Reason.	Higher Crustacia.	14 weeks.	22
	21	Association by similarity.	Fish and Batrachia.	12 weeks.	21
	20	Recognition of offspring, Secondary instincts.	Insects and Spiders.	10 weeks.	20
	19	Association by contiguity.	Mollusca.	7 weeks.	19
	18	Primary instincts.	Larvæ of Insects, Annelida.	3 weeks.	18
	17	Memory.	Echinodermata.	1 week.	17
	16	Pleasures and pains.		Birth.	16
	15		Cœlenterata.		15
	14	Nervous adjustments.			14
	13				13
	12		Unknown animals,		12
	11	Partly nervous adjustments.	probably Cœlenterata.		11
	10		perhaps extinct.	Embryo.	10
	9				9
	8				8
	7	Non-nervous adjustments.	Unicellular organisms.		7
	6				6
	5				5
	4				4
	3	Protoplasmic movements.	Protoplasmic organisms.	Ovum and	3
	2				2
	1			Spermatozoa	1

Consciousness

blance between animal and human psychology. So far, therefore, as we are now concerned with the will, we have only to note that up to the point where the volitions of a man begin to surpass those of a brute in respect of complexity, refinement, and foresight, no one disputes identity of kind.

Lastly, the same remark applies to the faculties of intellect.* Enormous as the difference undoubtedly is between these faculties in the two cases, the difference is conceded not to be one of kind *ab initio*. On the contrary, it is conceded that up to a certain point—namely, as far as the highest degree of intelligence to which an animal attains—there is not merely a similarity of kind but an identity of correspondence. In other words, the parallel between animal and human intelligence which is presented in the diagram is not disputed. The question, therefore, only arises with reference to those superadded faculties which are represented above the level marked twenty-eight, where the upward growth of animal intelligence ends, and the growth of distinctively human intelligence begins. But even at level twenty-eight the human mind is already in possession of many of its most useful faculties, and these it does not afterward shed, but carries them upward with it in the course of its further development—as we well know by observing the psychogenesis of every child. Now, it belongs to the very essence of evolution, considered as a process, that when one order of existence passes on to higher grades of excellence, it does so upon the foundation already laid by the previous course of its progress; so that when compared with any allied order of existence which has not been carried so far in this upward course, a more or less close parallel admits of being traced between the two, up to the point at which the one begins to distance the other, where all further comparison admittedly ends. Therefore, upon the face of them, the facts of comparative psychology now before us are, to say the least, strongly suggestive of the superadded powers of the human intellect having been due to a process of evolution.

Lest it should be thought that in this preliminary sketch of the resemblances between human and brute psychology I have been endeavoring to draw the lines with a biased hand, I will here quote a short passage to show that I have not misrepresented the extent to which agreement prevails among adherents of otherwise

* Of course, my opponents will not allow that this word can be properly applied to the psychology of any brute. But I am not now using it in a question-begging sense: I am using it only to avoid the otherwise necessary expedient of coining a new term. Whatever view we may take as to the relations between human and animal psychology, we must in some way distinguish between the different ingredients of each, and so between the instinct, the emotion, and the intelligence of an animal. (See "Mental Evolution in Animals," p. 335 *et seq.*)

opposite opinions. And for this purpose I select as spokesman a distinguished naturalist, who is also an able psychologist, and to whom, therefore, I shall afterward have occasion frequently to refer, as on both these accounts the most competent as well as the most representative of my opponents. In his presidential address before the Biological Section of the British Association in 1879, Mr. Mivart is reported to have said:

"I have no wish to ignore the marvelous powers of animals, or the resemblance of their actions to those of man. No one can reasonably deny that many of them have feelings, emotions, and sense-perceptions similar to our own; that they exercise voluntary motion, and perform actions grouped in complex ways for definite ends; that they to a certain extent learn by experience, and combine perceptions and reminiscences so as to draw practical inferences, directly apprehending objects standing in different relations one to another, so that, in a sense, they may be said to apprehend relations. They will show hesitation, ending apparently, after a conflict of desires, with what looks like choice or volition; and such animals as the dog will not only exhibit the most marvelous fidelity and affection, but will also manifest evident signs of shame, which may seem the outcome of incipient moral perceptions. It is no great wonder, then, that so many persons, little given to patient and careful introspection, should fail to perceive any radical distinction between a nature thus gifted and the intellectual nature of man."

SCIENCE AND "CHRISTIAN SCIENCE."

By FREDERIK A. FERNALD.

THE doctrine known as Christian Science has gained so large a number of followers, it promises the freedom from disease which so many afflicted persons are longing for, it appeals to the religious sentiments, which are so powerful to sway the mass of mankind, and also claims a basis in science from which the world is constantly expecting fresh surprises, that it has aroused the interest of thousands who are trying to decide whether it is a revelation of truth or a contagious delusion.

Christian Science was "discovered" by Mrs. Mary B. Eddy, then of Lynn, Mass., in 1866. The leading features of her doctrine are that "everything is Mind," that there is but one Mind, which is God, and that "man is the idea of God." Our bodies, and the things around us, houses and furniture, trees, rocks, and earth—all things composed of matter—do not really exist, but are only the ideas of mind, something like the things of a dream. Matter,

being unreal, can not feel or know anything, and hence can not be sick; and mind, being divine, is perfect, and hence can not be sick either. Therefore, there can be no sickness in anything, and what we call sickness is only a belief—not a belief of the one Divine Mind, but a belief of what she calls "mortal mind," which is itself unreal. Hence, when the belief is destroyed, the disease is destroyed also. She deems this theory fully verified, because, proceeding in accordance with it, she states that she has "prevented disease, preserved and restored health, healed chronic as well as acute ailments in their severest forms, elongated shortened limbs, relaxed rigid muscles, restored decaying bones to healthy conditions, brought back the lost substance of the lungs, and caused them to resume their proper functions." She asserts that sin is an error of similar nature with disease, and yields to similar treatment. "Healing the sick and reforming the sinner are one and the same thing in Christian Science." Death also is all a mistake. The doctrine is set forth very fully in Mrs. Eddy's book, "Science and Health," of which over thirty thousand copies have been sold. Many other books and pamphlets have been published by the Christian Scientists, and they issue a number of periodicals, the chief of which are: "The Christian Science Journal" and "The Mental Healing Monthly," in Boston; "The International Magazine of Christian Science," in New York; and "The Mental Science Magazine" and "The Christian Metaphysician," in Chicago. In each of these cities there are several "schools," "institutes," and "universities" for the teaching of "Christian Science," or "metaphysical healing," or the "science of spirit," or "Christian pneumatopathy," or essentially the same thing by some other name; and there are one or more such institutions in a number of other cities.

The two parts of the name "Christian Science" indicate that the doctrine has a mixed character. As to the genuineness of its Christianity, the doctors of divinity are best qualified to judge; the religious side of the subject lies outside the domain of science, and will not be treated here. I will only say that the garb of religion has often been a convenient cloak for fraud and delusion. But Mrs. Eddy calls her system of healing a science. If it really has the character of a science, it will endure all the tests that a genuine science will endure. If Christian Science is true, not only should cures always result when its precepts are followed, but, when a part of the theory is disregarded, failure should be sure to result. Any mental healer who tried to cure disease without denying that disease exists, or without denying that matter exists, or without asserting that all mind is one, should meet with discomfiture and defeat. In the case of a genuine scientific doctrine, such as the law of gravitation, any

operation like the erection of a tower or the calculation of the path of a cannon-ball will result in success or failure according as it is or is not performed in complete agreement with this law.

Now, the Christian Scientists are continually making failures. Patients whom they have treated for a long time still have poor health. The healers plead that these patients have been helped some, but the gain is doubtful; and, besides, their theory does not leave room for any partial successes. "The rule, and its perfectness in my system, never vary," says Mrs. Eddy. There are other patients who might have been numbered among the successes of Christian Science if they had not unfortunately died under the treatment. Such instances furnish frequent items for the newspapers. "The Medical and Surgical Reporter" gives this case: The wife of a physician in Cincinnati had a cancer. The growth was removed, but after some months the disease reappeared, and everything that the best medical skill of the country could do for the patient proved in vain. She was urged to try the faith-cure, but her husband naturally refused to allow this. When, however, it began to be whispered about that, because she was married to a physician, she must die for want of freedom to avail herself of all methods of cure, he could resist no longer. Under his protest she went to the faith-healers, and every day they told her that she was getting better, while she was really growing worse, and soon died.

"The New York Herald" prints the following:

Chicago, Ill., February 21, 1888.—F. Benedict, late an employé at W. W. Kimball & Company's piano ware-rooms, lies dead in the La Burnham flats, a victim to "faith-healing," and to-morrow Dr. C. R. Teed, the editor of the Christian Science organ, "The Guiding Star," will be called upon to answer charges of criminal malpractice in connection with the case.

From the "Boston Herald" I learn that Mrs. Lottie A. James, of West Medford, Mass., died April 20, 1888, in childbirth, under the treatment of her mother, who was a Christian Scientist. The child also died. Her husband was absent. The mother was charged with manslaughter, but the grand jury failed to indict her. The following item appeared in the "New York Tribune":

Springfield, Mo., May 28th.—Mrs. John Truesdale last night drowned herself in a reservoir. She had acted strangely for the last two or three weeks, owing to strict adherence to the teachings of a Christian Scientist, James Reed. He told Mrs. Truesdale that he could teach her the science of healing by prayer so that she could heal her husband, who is an engineer, but has been ill with consumption for several months. Grasping at anything that promised any hope for her husband, she visited Reed frequently, and the general opinion is that out of her experience grew the despair that caused her to kill herself.

Still another case was reported in "The New York Times":

Chicago, May 30th.—There is another unpleasant case for the faith-healers to explain. Mrs. Mary Reiter, a young woman, came to this city from Valparaiso, Ind., recently, suffering from pulmonary troubles, and put herself under the care of Mrs. J. C. Barker, a Christian Scientist, for treatment. She died last night, and the faith-healer being unable to give a death-certificate, the coroner to-day took up the case.

Like Dr. Frog in the fable, these physicians also fail to cure themselves. Arlo Bates writes to the "Providence Journal" that a prominent Boston dentist was called from his bed at two o'clock one morning to go to the relief of a lady who was suffering the agonies of toothache. He at first declined to go, but finally went, relieved her pain, and went again in the daytime to do something more to the teeth. He had not taken much notice of the name given him at his first visit, but on reaching the house the second time his eye fell on the door-plate, and he found that he had been called in such hot haste to relieve the pain of one who makes a handsome income by teaching that there is no such thing as pain. His patient was a shining light of Christian Science, but she could not cure her own toothache!

Mr. Charles M. Barrows mentions the following cases in his "Facts and Fictions of Mental Healing": "About three years ago a well-known citizen of Boston was thoroughly cured, to all appearance, of a distressing chronic malady, and embraced the doctrines advocated by his healer, a 'Christian Scientist.' He also became a very successful healer of others, and was so confident in his own ability to resist disease that he frequently declared it was impossible for him ever to be sick. Yet within a twelvemonth this same man, who sincerely thought he had risen superior to all finite ills, was hurried to the grave by a hæmorrhage of the lungs. During the past year four active mental healers have succumbed to the fell destroyer of mortal life; and only last summer one of the great lights of 'Christian Science' was prostrated with nervous exhaustion and obliged to seek medical aid."

Any theory of physics or chemistry which admitted of such utter failures as Christian Science suffers would be pronounced, even by its friends, unworthy the name of science. Mrs. Eddy does not take these failures as indications that her theory needs modifying, but throws the blame of them upon her luckless disciples. She says to her pupils, "If you fail to succeed in any case, it is because you have not demonstrated the rule and proved the principle." She and her theory remain infallible, but she has avoided inconvenient tests of her own powers of late years, and prints in her book this note: "The authoress takes no patients,

and has no time for medical consultation." As president of the "Massachusetts Metaphysical College," she doubtless feels that her time is more profitably used, and her luxurious home on Boston's finest avenue testifies to the magnitude of the profits.

If Mrs. Eddy can claim that failures are sufficient proof that the healer does not practice the right method, she must likewise accept success as sufficient proof that the healer does practice the right method. Now there are several *different methods*. Although she denounces as heresy any deviation from her doctrine, yet some of her former disciples, who do not hold that every person's mind is a part of the Divine Being, have success in healing that will compare favorably with that of the faithful. Hence this part of Mrs. Eddy's doctrine is of no consequence in healing. These heretics prefer to be called "mental healers." Then there is the faith-cure, with its "Beth-shan," in London, its conventions at Old Orchard, Maine, and its sanctuary in Jersey City. It has also been used somewhat in England by the Salvation Army. The theory of the faith-curers is simply an extension of the Christian's belief in the efficacy of prayer for the sick. They do not assert that matter is unreal, and that nothing exists but mind, yet they perform enough cures to show that this part also of Mrs. Eddy's doctrine is of no consequence in the practice of healing.

A variety of faith-healing has been practiced in the Roman Catholic Church for hundreds of years. There is plenty of testimony, as good as the Christian Scientists can furnish, that persons have been healed by the aid of the prayers of priests and bishops, by touching the bones or other relics of saints, or by bathing in the water of sacred springs. A noted locality for such cures at the present time is the grotto of Lourdes in France. The Mormons are not behind the Catholics or Protestants in making cures. One of the chief methods employed by their missionaries in gaining converts is to pray with the sick, who often recover and join the sect. The cures credited to the wonderful Dr. Newton, who flourished twenty-five to thirty years ago, as well as those which gained Dr. Perkins's "tractors" their fame at the close of the last century, must be counted as mental healing. Hence, there have been successful mind-curers before Mrs. Eddy, although their theories agreed in little or nothing with hers. In fact, from the teachings of one of the irregular healers who preceded her, Mr. P. P. Quimby, Mrs. Eddy is charged with appropriating everything of importance in her system. This charge she indignantly denies.

Moreover, cures have been effected when healer and patient held a belief that was demonstrably *false*. Prince Radzivil, of

Lithuania, visiting Rome at the time of the Reformation, received from the pope a box of precious relics. After he reached home the relics were used by the monks for the cure of a demoniac, who had held out against every kind of exorcism. The success was instantaneous and complete. But the prince observed a knowing smile on the face of the young man who had been keeper of the relics, and upon inquiry learned to his disgust that the genuine relics had been lost on the journey, and their place had been supplied with bones of cats and dogs picked up by the road. This lot of rubbish it was that had performed the miracle. Any one who believed that the touch of Queen Victoria's hand could cure him of scrofula (king's evil) would be unanimously declared out of his mind; yet it was the general belief in England for seven hundred years, from the reign of Edward the Confessor to that of Queen Anne, that the touch of the royal hand could heal this disease. Historians and physicians of the time testify to the usual success of the operation. Every one has read of the noisy antics employed by the medicine-men among the Indians, and by the fetich-doctors and voodoos among the negroes, for driving diseases out of their patients. Explorers and missionaries report that surprising cures often follow such treatment. No Christian Scientist would acknowledge fellowship with these ignorant impostors, and yet the voodoos cure disease without material means like the disciples of Mrs. Eddy.

I do not wish to be understood as giving full credit to all the reports of cures by any of these agencies. Doubtless in many instances the recovery is spontaneous; it is effected by the healing power of nature, and in spite of the treatment rather than by means of it. The patients would have got well as soon or sooner if nothing had been done for them. Moreover, in many cases reported by persons with little medical knowledge, the disease was not as serious, and hence the cure was not as wonderful, as is represented. Still, there remains enough evidence to show that in each one of the above ways real disease has been thrown off by aid of mental influence.

Furthermore, disease has been cured, with no theory of treatment whatever, by an *accidental* impression made on the mind. Mr. Barrows tells the following: The wife of a wealthy Pennsylvania farmer had been bedridden for many years, and unable to rise or walk without help. A Baptist minister visited the family, and the host showed him about his thrifty farm, in which he evidently took an honest pride. "Your farm seems to be one of the best in this section," observed the guest. "Yes, it is, sir," answered the host, with a beaming face; "and, what is more, it's all paid for." Similar comments on the barns, stock, etc., brought forth assurances that they, too, were "all paid for." Dinner-time came, and

the family, with their guest, gathered at the table. The invalid occupied a bedroom adjoining the dining-room, in order that when the family were at table she might hear their conversation through the open door. The clergyman was asked to say grace, and began thus:

"O Lord, we thank thee for the abundance now spread before us; we thank thee that it is all paid for—"

Here a sudden interruption came from the invalid in the next room, who, on hearing her husband's pet phrase put into a prayer, burst into a fit of uncontrollable laughter. Entirely forgetting her condition, she sprang out of bed, and stood holding her sides and shaking all over with mirth when the family rushed in. That solemn joke cured her, leaving nothing to be paid for. The same author tells of a New Hampshire lady who was also cured after being bedridden for a long time. In pleasant weather her grown-up sons used to lift their mother tenderly into a carriage, and take her for a drive. It was their opinion, however, that her case demanded heroic treatment, and they resolved to make the experiment. Near the house a brook crossed the road, through which they often drove to let the horse drink, instead of crossing by the bridge. The ford was usually safe and easy; but one day the carriage was suddenly upset by some stones previously placed in the water by the boys, and the invalid was thrown into the middle of the stream, from which she must scramble out or drown. She fathomed the well-meant plot, and was very angry; but the remedy was effectual, and her lameness was cured on the spot. A lady in California, who had suffered much from neuralgia and become blind, on hearing an alarm of fire regained her sight. Accidental mental excitement caused by explosions at the cartridge-factory in Bridgeport, Conn., has cured many cases of intermittent fever. A physician, writing to the "Medical News," tells of a man being cured of a chronic rheumatism, and another of nervous exhaustion, by the earthquake-shock at Charleston.

Hence we see that disease can be cured through the mind in a great variety of ways. The true science of mind-cure will explain all of them, but Mrs. Eddy's doctrine does not satisfy this condition. Moreover, hers is a complicated theory; and experience has shown that in science, where the facts can be explained in a simpler way, a complicated theory is likely to be false. Furthermore, a theory which, like Mrs. Eddy's, contradicts scientific laws that we see proved true every day of our lives, can not itself be true also. If her "Science" were to become established, all that we now know as science would have to be abandoned as inconsistent with it. Not only would the science of physiology, which she directly attacks, be destroyed, but the sciences of physics,

chemistry, zoölogy, botany, astronomy, and geology would also be reduced to chaos, for these together with physiology are based on observation and induction, which Mrs. Eddy declares we can not trust. "Christian Science eschews what is termed natural science," she says, and she condemns the use of observation when she asserts that "it is morally wrong to examine the body in order to ascertain if we are in health." "Putting on the full armor of physiology, and obeying to the letter the so-called laws of health (so the statistics show), have neither diminished sickness nor lengthened life"! On the other hand, she affirms that "science is the watchword of our day," and calls attention to some of its benefits; in another place she indorses the results of astronomy. But that she is wofully ignorant of science is shown by such expressions as, "The angle of incidence is the reverse of the angles in the objects reflected"; "The blind forces called attraction, adhesion, and cohesion are not substances of matter"; "We tread on forces. Withdraw them, and the universe would collapse."

The genuine science of mental therapeutics is a very simple one. It has been discovered by physicians here and there at various times, and, if not adequately developed, it at least does not contradict the principles on which all science is based. The theory is, that mental impressions, however produced, act through the nervous system upon the various organs of the body so as to stimulate or obstruct their functions as the case may be. Such mental action is a matter of common observation. Whenever the cheek flushes with embarrassment or pales with fear, mental influence is producing its effect on the body. Great anxiety or grief causes loss of appetite, and may bring on an attack of dyspepsia or any other disease to which the person is liable. Fright has turned the hair gray in a few hours. Dr. Murchison wrote: "That jaundice may have a nervous origin has long been known. There are numerous instances on record of its being produced by severe mental emotions, such as fits of anger, fear, shame, or great bodily suffering."

Dr. Durand, of New Orleans, according to the "Picayune" of that city, recently made a test of mental influence by giving a hundred patients a dose of sweetened water. Fifteen minutes after, entering apparently in great excitement, he announced that he had by mistake given a powerful emetic, and preparations must be made accordingly. Eighty out of the hundred patients soon fell to vomiting.

On the other hand, the tonic effects on a patient of hope, cheerfulness, and a determination to get well, have been frequently commented upon, and many intelligent physicians have made good use of such mental aids in practice. Dr. John Hunter wrote

a century ago, "There is not a natural action in the body, whether involuntary or voluntary, that may not be influenced by the peculiar state of the mind at the time." The chief store-house of facts of this class is Dr. D. Hack Tuke's work on "The Influence of the Mind upon the Body in Health and Disease" (London, 1872), his attention having been called to the subject in 1869 by a newspaper article on "The Curative Effects of a Railway Collision." The evidence furnished by Tuke and other writers leaves no room to doubt that mental action is a powerful agency which can be applied in the cure of disease.

Dr. Tuke says, in the preface to his classic work: "There are two classes of readers to whom I wish more especially to address myself. The medical reader who, I hope, may be induced to employ psycho-therapeutics in a more methodical way than heretofore, and thus copy nature in those interesting instances, occasionally occurring, of sudden recovery from the spontaneous action of some powerful moral cause, by employing the same force designedly, instead of leaving it to mere chance. The force is there, acting irregularly and capriciously. The question is, whether it can not be applied and guided with skill and wisdom by the physician. . . . 'Remember,' said Dr. Rush, in addressing medical students, 'how many of our most useful remedies have been discovered by quacks. Do not be afraid, therefore, of conversing with them, and of profiting by their ignorance and temerity.'" Not only when disguised under some pretentious and illogical quackery has the mental force been employed, but it has already been utilized, with a full appreciation of its nature, by physicians of high standing. Sir Humphry Davy's cure of a case of paralysis by repeated applications of a thermometer is a much-quoted instance.

In a paper entitled "Bodily Conditions as related to Mental States" ("Popular Science Monthly," vol. xv, page 40), Dr. C. F. Taylor, of New York, reports the case of a young man sent to him from a Western city. Dr. Taylor was informed that the patient had broken his thigh-bone two years before, that this fracture had united, but that a year later the same bone had been broken in another place. The regular treatment had failed to secure a union of the second fracture. On examination, Dr. Taylor found the muscles of the leg wasted and soft, with a large outward bending in the middle of the bone, but he could not find the slightest evidence that *any second fracture had occurred.* The patient *thought* he had refractured his thigh-bone, and this impression caused him quite unconsciously to withhold muscular action in the limb so completely that a relaxed and powerless condition was caused, which was mistaken for a broken bone. A mere explanation of his condition was not sufficient to enable him

to relax his mental hold on the limb. Dr. Taylor caused the young man to take certain exercises with his arms, of so violent a character that they absorbed all his attention, leaving none for his lower limbs. Within three days he gave up restraining the injured leg, and he began to walk involuntarily. In this case it was the mind which needed treatment. A young lady was sent to Dr. Taylor from Albany for a supposed partial paralysis of the left foot and ankle, which caused her to drop her toes in walking. Her trouble proved to be entirely mental, and she was cured within ten days by restoring consciousness of power in the affected foot. He gives other cases to show that mental influence over bodily function causes not only loss of muscular power, but also increased muscular action simulating muscular spasm, increased or diminished bodily sensations, and disorders in the involuntary processes of life. His experience indicates that in such cases treatment directed toward the mind is the only sort that can be effective. He only alludes to "the important subject of mental influence on actual disease" in this article. "Suffice it here to say," he remarks, "that, as must be inferred from the facts and arguments already adduced, no system of therapeutics can be complete which does not embrace the design of controlling psycho-biological relations in general, and with reference to chronic diseases especially."

Prof. G. Buchanan, of Glasgow, has placed on record cases of the same nature as these described by Dr. Taylor. Still others are related by Walter Moxon ("Contemporary Review," vol. xlviii, p. 707) and by other writers. Animal magnetism, first brought forward as a healing agency by Mesmer a century ago, has since been studied scientifically under the name of hypnotism. The work of these later investigators has established the fact that a large number of functional diseases are benefited, and even permanently cured, through the mind by hypnotic suggestion.

Now, in view of what has been done in curing disease by the aid of mental influence, the public has a right to demand that our physicians shall give us the benefit of this healing agency. Mental influence is a pleasant and inexpensive medicine; it cures in some cases where drugs fail, and it shortens the term of sickness and lightens its pains in many other cases; furthermore, it has no injurious incidental effects. But the mind-cure should be taken out of the hands of the untrained and irresponsible visionaries and the impostors who now practice it, or it will add a terrible amount of suffering and death to what it has already caused. These enthusiasts, carried away by their seeming successes in a few cases, insist that the mind-cure is the only treatment that is worth anything in all diseases and for all persons. They know too little

about the nature of disease to recognize symptoms which indicate the fitness of this agency, too little of science in general to realize that a means suitable to remove one condition may be entirely inadequate or unsuitable to counteract another. Hardly a means of healing is known but had extravagant claims and prophecies made for it when it was first brought into use, which afterward settled down into a very moderate compass. Take, for instance, the transfusion of blood. The early transfusionists reasoned, in the style of the Christian Scientists, that the blood is the life. Take the bad blood out of a man and put new blood into him, and you draw off his diseases and infirmities and put new life into him. They even hoped to dispel insanity by this infusion of new life, and some went so far as to prophesy that moral infirmities would be cured in this way. The theory of Christian Science may seem very beautiful to persons of a highly religious and highly emotional nature, but it has no more connection with the cure of disease than a rainbow has with the multiplication table. It is a pretty fancy, and one hardly has the heart to dispel the illusion, but it is "as false as it is fair." Many of the most sanctimonious healers, who make the most impressive appeals to the piety of their victims, are in the business simply for the money they can get out of it. Others are honest, but are themselves deceived. It is fortunate that the patients of the Christian Scientists generally go back to the physicians when anything serious is the matter with them, or we should see a greater slaughter than has already occurred. About ninety-five per cent of the believers in this doctrine are women, and to their sensitive feelings the above may seem like ill-natured and hasty language. But it is neither. It is an earnest and deliberate effort to use the tests of science so as to show how unsubstantial is this rainbow-bridge upon which they are asked to trust their lives.

The Christian Science craze will have its day and then die out, like the blue-glass delusion and other crazes of like character. Already signs appear that it has reached its highest limit in the eastern part of the country, and that its decadence has begun. It is not occupying so much space as formerly in the newspapers; and it is becoming less profitable to those who practice it. A lady and her husband who set up a Christian Science school and hospital in New York recently found themselves a thousand dollars out at the end of the winter and gave up the business. In the West, however, where it appeared later, the movement still maintains considerable vigor.

It will have done good if it compels physicians to adopt mental healing, not as a panacea, but as an addition to the curative means now at their command, and for occasional intelligent use. This done, the sooner Christian Science, as a distinct mode of treat-

ment, passes away, the better for all concerned. It is one more of those wonders of which Byron wrote:

> "Thus saith the preacher, 'Naught beneath the sun
> Is new,' yet still from change to change we run;
> What varied wonders tempt us as they pass!
> The cow-pox, tractors, galvanism, and gas
> In turns appear, to make the vulgar stare,
> Till the swollen bubble bursts—and all is air!"
>
> —*English Bards and Scotch Reviewers.*

ON THE CAUSES OF VARIATION.*

By C. V. RILEY, Ph. D., United States Entomologist.

II.—*Concluded.*

HAVING thus summarily indicated those factors of evolution associated with genesis and which are essentially physiological, however much psychical phenomena may co-operate, we may touch upon the more purely psychical factors or those pertaining to the growth and use of mind, employing the term to express those neural phenomena traceable to the medium of the brain. Their importance in evolution increases with increasing cephalization and complexity of nerve system. For the present purpose, however, it is with the objective side of psychology, or what may be called psycho-physiology, that we must deal.

Psychical—Use and Disuse.—Full consideration of the effect of use and disuse involves a discussion, not only of the question of the transmission of acquired structures, but of the influence of individual effort and of necessity—i. e., a consideration of the essentially Lamarckian factors in evolution. The occasion will not permit me to do full justice to these subjects. That functionally produced modifications are inherited was the great assumption upon which Lamarck founded his theory of evolution. Many able naturalists have insisted on it, and in my judgment there should no longer be any doubt whatever of the fact, not only so far as grosser structure is concerned, but brain-structure likewise. No question is of more moment in the whole range of biology, and especially biologic philosophy, and Spencer has well pointed out that on the answer to it will depend largely the sciences of psychology, ethics, and sociology. Weismann, Lankester, and others deny hereditary power in such modifications, the former believing that hereditary modification can result only from changes in the *germ plasma*, i. e., are virtually congenital. Natural selection, according to this view, plays upon the germ plasma; but I have

* From the address of the Vice-President of Section F of the American Association for the Advancement of Science, delivered at the Cleveland meeting, August, 1888.

never been quite able to comprehend how this view, even if established, militates against the transmissibility of acquired modification; for, whatever theory of heredity we adopt, it shows us rather the manner of the transmission, and therefore confirms its possibility. But the fact of such transmissibility rests neither on embryological nor theoretical grounds. It is a fact so fully demonstrated in the history of our domestic animals and the history of agriculture, that the skepticism of some of our great naturalists and embryologists must be attributed to that ignorance of the farmers' commonest experiences which is, unfortunately, a too frequent attribute of the city-trained investigator. Darwin in the beginning, and while the importance of natural selection was growing in his mind, allowed little importance to use and disuse, for the same reason that he subordinated external agencies; viz., that, in proportion as it acts on masses simultaneously, it must diminish the importance of natural selection. Yet he allowed more weight to it toward the end, and has furnished some of the best evidence drawn from domestic animals of the transmission of acquired characters affecting the dermal, muscular, osseous, and nervous systems. Spencer has shown that inheritance of functional modification is most easily observed and experimentally proved in those parts which admit of easy observation and comparison, as the dermal covering and the bones; and that they for the most part are beyond these tests in the muscular and nervous systems. Yet he logically concludes:

"Considering that unquestionably the modification of structure by function is a *vera causa*, in so far as concerns the individual; and considering the number of facts which so competent an observer as Mr. Darwin regarded as evidence that transmission of such modifications takes place in particular cases; the hypothesis that such transmission takes place in conformity with a general law, holding of all active structures, should, I think, be regarded as at least a good working hypothesis."

So far as entomology bears evidence, it confirms the fact that modifications of structure due to use or disuse on the part of the individual may be and are transmitted. These are easily observed in the exo-skeleton, and, while the experimental proof is yet limited, it is not wanting, especially in the history of apiculture. Excessive use of any organ will develop or enlarge it at the expense of other organs, just as disuse will cause a diminution or atrophy thereof. The variation in the individual will be within limits, but, when once the variation has set in, the tendency is always to an increased variation in the same direction in the descendants, especially if they continue the same use or disuse. Here, again, however, it is difficult to separate the modification due to individual effort, or want of effort, and the more general

modification affecting the mass of individuals of a species through the environment; because the environment affects function, and function in its turn affects form and structure. The life of every individual furnishes an excellent illustration of new action and new uses for organs not previously used, in the striking and sudden employment of post-natal organs, both of respiration and nourishment, which pre-natally had no corresponding action. Romanes has argued that *cessation of selection* may reduce an organ where use or disuse can have no play, as in the loss of wings in neuter ants; and that by the law of compensation an organ may even be increased, as in the heads of such neuters. He enforces the idea by exampling the blind crabs of our Kentucky caves, where the complex eyes rapidly disappear under cessation of selection, but where the persistence of the foot-stalks indicates that economy of nutrition could have had little play! It is difficult, however, to draw the line between this cause and Lankester's reversal of natural selection; and still more difficult to say wherein either differs from mere disuse.

Degeneration, which has been urged as the true explanation of many of the existing forms of life, is, it seems to me, but a consequence of disuse, and would, therefore, fall into the present category, among causes of variation.

Emotion as affecting the Individual.—I have here considered the factor of use and disuse as a direct cause of variation, from the psychical rather than the physical standpoint—i. e., individual or conscious effort as furnishing food for natural selection, among more highly endowed animals, rather than as effort by species as a whole necessitated by physical conditions, and inducing modification in masses irrespective of selection. This leads us to the consideration of mind as a factor in evolution, and we shall soon see its importance as a fundamental cause of differentiation, among higher organisms at least. I am not sure, even, that its influence can be excluded from among lower animals, however much we may have to exclude its action in so far as plants are concerned; for any new functional effort inducing new use may be looked upon as conscious and intelligent as compared with use fixed by habit and lapsed into automatic action or instinct. The former typifies variability and progress; the latter constancy and stability.

Mind is a comprehensive cause of variation, and may be considered under several categories. We have, for instance, (1) the action of the mind of the individual in willing, or in selecting between differing alternatives that present themselves, as in the choice of means to ends; (2) the direct influence of the emotions on the individual; and (3) the influence of the emotions of the mother on her unborn offspring.

In the first category, the influence of mind in modifying is chiefly confined to man. It must have acted from the time when he first began to prepare his crude weapons of defense and offense to the present day, when some new discovery or some new invention may alter the map of the world, revolutionize society, or give one race or nation the advantage over another; nor can we feel sure that animals below man have not been modified by similar psychical effort. In the second category, the direct influence of the emotions on the individual, it is a psycho-physiological factor involved in the question of use and disuse; for if it be once admitted (and I think the tendency of modern neural science is in the direction of establishing the fact) that strong mental effort may be made to affect special parts of the body—i. e., that an excess of nervous force brought to play on any particular organ, or any particular part of the organism, induces increased growth or development of such parts; we can understand how far desire, especially under the spur of necessity, may be influential in inducing modification. Lamarck's idea, therefore, may not be so ridiculous as it has hitherto been supposed by many. Darwin took no stock in this influence, and referred with some contempt to the views of Lamarck and Geoffroy Saint-Hilaire. He thought it strange that the author of "Les Animaux sans Vertèbres" should have written that insects which never saw their eggs should will them to be of particular form, which he thought hardly less absurd than to believe that the desire to climb should make a pediculus formed to climb hair, or a woodpecker to climb trees.

Emotion of Mother as affecting Offspring.—There may be some doubt about the extent of the influence of the individual mind in inducing direct modification, for the subject is a difficult one to deal with, and we have few exact data to draw from. Since in human affairs we recognize the power of will in affecting purpose and action, and in molding character, it is legitimate to infer that when our knowledge has increased we shall recognize its effect on function. There can be less doubt as to the third category, viz., influence of the mind or emotions of the mother on her unborn offspring in inducing modification both physiological and mental. As a cause of variation, though believed in by J. D. Hooker, as we learn from the "Life and Letters," and by other of Darwin's contemporaries, it was discarded by Darwin himself, his principal reasons being that the results of observations made for him in hospitals were adverse to any such influence. Medical men, as a rule, also discard it as among the mere notions and superstitions of women, and argue its impossibility on the ground that there is no neural connection between mother and fœtus. The ancients practically recognized the influence of the imagination of the

mother on her offspring, and belief in it is still very prevalent among women themselves, of all classes. Women alone are able to speak or feel in this matter from experience, and the almost universal belief in the influence, among those who have any experience at all, should make us hesitate to discard it too summarily. From facts within my own personal knowledge I have long believed in this influence, and the more I have been able to collect reliable data bearing upon it, the more confirmed have I become in the conclusion that the emotional experiences of the mother affect the issue in varying degree, according to the intensity of the emotion. When sudden and excessive, as in rage, fright, repugnance, etc., or where prolonged or accumulative, as in continued brooding, it may induce nervous disorders, and even mental aberration, idiocy, or insanity; or, again, physiological change, as atrophy or increase of parts, and other peculiarities which have relation to the form or character of the inducing mental manifestation or shock in the parent. Investigation of this, as of all subtle phenomena, is attended with the difficulty of separating the chaff of fancy from the grain of reality. The method pursued by Darwin is unsatisfactory, as it dealt with normal conditions which furnish no evidence and with the fanciful or notional side of the subject. The literature of the subject is extensive and quite interesting, and I would refer particularly to the work and writings of Viellard, Schönfeld, Demangeon, Lucas, Féré, and Brown-Séquard. Two other difficulties confront the investigator: first, the somewhat unsatisfactory state of neurology and the difficulty of experimental research therein, as indicated by Vice-President Bowditch before this section two years ago; secondly, the aversion, from feelings of delicacy, on the part of the persons concerned, to publicity of the more marked and striking evidence. The phenomena of hypnotism, proving as they do that physiological results may be induced through the imagination of the subject acted on by the mind of the hypnotizer, are suggestive in this connection, the work of Charcot in Paris more particularly showing how powerful the action may be, and how the effects of actual medicines may be produced by the use of imagined ones. The mind of the hypnotized under these conditions is brought into those exceptional and exalted conditions which are necessary in the case of the mother to produce on her offspring the effect which we are discussing. The recent experiments of Mr. C. T. Hodge on the effects of stimulation on the nucleus and cell-body and on protoplasm are also interesting here, showing, as they do, decrease in the two former and vacuolation of the latter as the result.

The history of science is present to tell us that common and persistent belief, based on experience, has not infrequently been

met with skepticism and even ridicule on the part of scientific men, only to be vindicated finally by more thorough and exact knowledge. It is too often the case that, where the processes are recondite and difficult to follow, assumption passes for knowledge. The function of some of our own bodily organs yet remains to be established, and we probably assume too much in requiring that all nervous force must be transferred through nerve tissue, or that there may not be protoplasmic filaments which are not resolvable, in their finer ramifications, even with our best microscopes. The very nature of mind and its processes puts it beyond the reach of the scalpel of the anatomist or the physiologist, just as many psychical phenomena baffle the exact methods of science, at least those so far employed. Leaving out of the question the evidence of peculiar marks due to maternal emotion, cases of which are part of the unwritten history of almost every family, the striking cases of which I have authoritative evidence of addition to, subtraction from, or singular modification of, anatomical parts, confirm me in the belief that this is a most important psycho-physiological cause of modification.

In the romance of "Elsie Venner," in which the heroine's strange attributes are connected with pre-natal influence of the mother, who died of the bite of *Crotalus*, Oliver Wendell Holmes has strongly put forth this doctrine in the form of fiction. I allude to this clever romance because of the medical knowledge of the eminent author, and because, while admitting in the preface that a grave scientific doctrine lies beneath some of the delineations of character, he also affirms that he has had the most startling confirmation of its truth. The data collected on the subject I hope to bring together on some other more fit occasion; and I would take this opportunity of urging any in my hearing, or who may read these lines, if they have had or are aware of any authoritative and illustrative cases, to communicate them to me with as much detail as possible.

This theory once established, its bearing on evolution as a prime cause of variation must at once be manifest; for it gives not only tangibility to the Lamarckian idea of desire influencing modification, but also a conception of how Infinite Mind in nature may act through the finite in directing such modification. No doubt but that there is a great deal of nonsense and superstition mixed with the genuine, and that the idea that every little whim, or fancy, or imagining of the mother will produce record or mark is one of the unjustified outcroppings of the fundamental fact, and helps to explain the difficulty of getting at the real facts and the ease with which Darwin rejected the idea. In my judgment, this factor acts only when, from whatever cause, and particularly under the spur of necessity, the emotions are exceptionally inten-

sified, or the desire strongly centered in some particular object. The conception is perfectly legitimate, for instance, that when a species is subjected to any external modifying cause, affecting all its members alike, the adaptive modifications which natural selection, under such circumstances, would play upon, have their origin in the emotions, or the influences at work on the pregnant females, giving direction in their offspring, to the needed changes. In this way it is probable that only those individuals born under such conditions would be able to survive. Thus this becomes no mere ancillary cause of variation, but one of deepest import and at the very foundation of evolution. The female in this light acquires an increased importance, and evolution finds her not only the essential at the dawn of life upon our planet, but, in its present highest manifestations, she is nearest by instinct, intuition, and aspiration to the Controlling Mind which in the beginning quickened the great womb of Nature and down through all the ages guided the continuous stream of life to designed ends through the womb of the individual mother.

As already remarked, the psychical factors which we have been considering are substantially Lamarckian, and in proportion as we consider them and get to understand the other direct causes of variation, must we give importance to the ideas of Lamarck and, conversely, less importance to the ideas of Darwin.

Did time permit, I should like to go into an analysis of Lamarck's "Philosophie zoologique," and show how the genius of this illustrious French naturalist anticipated a very large part of that which Darwin subsequently so laboriously helped to establish. I must pass the subject, however, and simply record my surprise that one who was otherwise so honest and fair toward other writers, was so evidently unfair in his estimate of the work of Lamarck, as Darwin, in the "Life and Letters," is shown to have been. It is incomprehensible, reading Lamarck with our present knowledge, that Darwin should have found neither fact nor ideas in a book which abounds in both, except on the theory of a poor translation or that strange national antipathy which has so often prevented the people of one country from doing justice to those of the other, and which so long prejudiced the French Academy against Darwin's own especial theories.

Darwinism assumes essential ignorance of the causes of variation, and is based on the inherent tendency thereto in the offspring. Lamarckism, on the contrary, recognizes in use and disuse, desire and the physical environment, immediate causes of variation affecting the individual and transmitted to the offspring, in which it may be intensified again both by inheritance and further individual modification. Both represent important principles in evolution and co-operate to bring about the results. The

theory I propose gives renewed importance to the Lamarckian factors by showing one manner of their action not previously urged, and it also helps us to a tangible and scientific conception of design.

Acceleration and Retardation.—In this rapid glance at the immediate causes of variation we have discussed some factors which in some degree represent laws rather than inducing causes of variation. This difficulty appertains to all attempts at formulation of the causes of variation, and only as our actual knowledge increases shall we be able succinctly and definitely to classify the factors. There are, however, certain important laws which have influenced modification but in no sense can be looked upon as causes of variation. They are laws or principles of evolution, by which we may account for the formation of types, acting, just as natural selection does, in differentiating rather than in originating the variation. No one can have followed the important and suggestive works of Cope and Hyatt on the subject of acceleration and retardation and not feel that it expresses an important law of this kind. It is, as I understand it, a factor in evolution not comparable with the principle of natural selection, but complementary thereto, much in the same way as physiological selection and sexual selection are. It is an attempt to give expression and form to a set of facts to which palæontology undoubtedly points and which ontogeny substantiates, viz., that certain types may attain perfection in time and then retrogress and finally become extinct, and that existing types which are dying out, or degenerating, exhibit, ontogenically, the culmination of force and complexity, followed by decadence, corresponding to the phylogenic history of the type. We know from the "Life and Letters" that Darwin gave up in despair the attempt to grasp the full meaning of these particular views of our associates, and, in a letter to Hyatt, with characteristic modesty, he attributes this inability to his own dullness rather than to any weakness in the theory. Others have experienced the same difficulty, and believe, with Prof. Morse, that the facts enumerated, as well as the facts of exact and inexact parallelism, are explicable on the doctrine of natural selection. This is true, it seems to me, only on the broader, unjustified interpretation of the doctrine to which I have previously alluded in the opening of these remarks. The law of acceleration and retardation may, perhaps, be substantially stated in this wise: that certain groups acquire some characters rapidly, while corresponding groups acquire the same characters more slowly, or never acquire them at all; and this brings us to another important factor of evolution which serves to give force to the law.

Acceleration by Primogeniture.—This has been elaborated by Hubrecht. He argues that so long as the parent form remained

most in harmony with the surrounding conditions, it would maintain in the struggle for existence its characteristics against all tendency to vary in its offspring, which is equivalent to saying that it will remain unchanged so long as the environment remains the same. He then shows that in organisms in which the reproductive period covers many years, accelerated development by primogeniture, i. e., as between the first born and the last born of any pair and of their posterity, will, in time, produce differentiation. The series of the first born will, in the course of time, involve many generations at short distances from each other, whereas the series of the last born will, on the contrary, consist of a much smaller number of terms, each separated from its predecessor by a more considerable distance. Any tendency to variation from external or internal influences must needs find more numerous occasions to act in the series of the first born, not only because these have a more composite ancestry, but because they necessarily become the most numerous. In other words, the chances are more numerous for small differences among the first-born series, and, in proportion as such differences are accumulated, intercrossing with the series of the last born will become rarer. This law will gain from physiological selection, and, it seems to me, throws additional light on that of acceleration and retardation. It must act more particularly among higher animals, where the reproductive period is lengthened, and the time between the first and last born is great.

Saltation.—We are thus led to what have been called saltations in evolution. Although the history of palæontology has continually added to our knowledge of past forms, and helped to fill up many gaps in the evolutional series, and although during the last quarter of a century it has particularly vindicated Darwin's prophecy that many links would yet be found, the substantial truth remains that gaps still occur, and that progress, so far as present knowledge indicates, has been made by occasional saltations. There have been, it would seem, periods of rapid movement, and of comparative repose or readjustment of equilibrium. Cope concludes that "genera and higher categories have appeared in geologic history by more or less abrupt transitions or *expression-points*, rather than by uniform gradual successions."

One of Pictet's strongest points in opposition to Darwin's theory, which struck Darwin himself with much force, was that it ill agreed with the history of organisms with well marked and defined forms, which seem to have existed during but a limited period, as, for instance, the flying reptiles, the ichthyosaurus, belemnites, ammonites, etc. Some authors, who have fully recognized these gaps or leaps in the developmental history of animals, yet believe them to be consistent with the theory of gradual modi-

fication. It may be only one individual of many which becomes modified and transmits the modification to descendants; it may be but one species of a genus which, for similar reasons, supersedes the rest which become extinct in time proportioned to prolificacy.

There is no reason to suppose that the history of organic life has differed in this respect from that of inorganic. We need not discuss here the question of catastrophism and uniformitarianism in geology However much the latter prevails at the present time, both have doubtless operated in the past. Catastrophism would necessarily produce gaps, or saltations, in the palæontological record, as only the more plastic species would adapt themselves and survive under its influence. It is not gaps due to such causes that are here to be considered, however, but those which occur in uniform strata. Haldeman has most suggestively remarked that the same mineral will crystallize with three, six, or twelve angles, but not with five or seven, and he asks, Are the facts of organic morphism subject to less definite laws? Cope has drawn another illustration from inorganic forces, in the three great changes in water, from solid, liquid, and vapor, which take place suddenly at what may be called two *expression-points* of the thermometer, the many intervening degrees involving no change. Rhythm or wave movement would seem to be a universal attribute of matter, whether organic or inorganic. The forces of nature are constant, but the phenomena induced are often paroxysmal. The progressive forces accumulate, while the conservative forces resist, until at last resistance gives way with comparative suddenness. There is every reason to believe that the life-movement, in its ascending complexity, has shared this common law. Accumulation is proportioned to the change in environment, and resistance to the age or rigidity of the organism. The latter may be strong enough to end in death or extinction, or it may break down, and, with comparatively sudden yielding and conformity to necessity, burst the confines and begin a new series of variations and adaptations. In either case we have breaks, because the dying or dropping out of one type makes room for another more accommodating. Rapid evolution, from causes already discussed, implies gaps which must be marked according as the strength of the conservative forces and the violence of the final accommodation are great, and because certain breaks are more apt to occur after long periods of stability. The break may be induced by changes in physical environment or without such change; if the latter, it will more likely occur in some individual born with a marked departure from the type that gives it some advantage, and whose issue will in time supplant all other individuals. In either case we shall have, palæontologically, distinct species or genera, one superposed on the other, without links.

To the imperfection of the geologic record is to be attributed, no doubt, a large number of these gaps yet existing between types, and many important links or branches are yet to be discovered. Yet the views we have been considering should absolve evolutionists from all necessity of demonstrating the more minute gradations; because, in deposits like the Tertiary, during which we may assume life-conditions to have remained comparatively uniform, these saltations take place. Saltation, or, what is probably a truer expression, wave-movement, would indeed seem to be a prerequisite of progress, and will account for much that is going on even at the present day. In artificial selection by man we find that it is at first comparatively easy to accumulate minute peculiarities and variations by rigid breeding and exclusion of all deviation; but that we soon arrive at a fixed point which is maintained at first with difficulty but with increasing ease with each generation. During these more fixed periods the potentiality for change is doubtless increasing, until at last it is suddenly manifested in renewed variation. Rest is followed by activity just as surely as activity induces and requires rest.

There is a limit to development in organs, just as there is a limit to individual mental growth. Weariness of previous effort comes upon us when the limit of result is attained, accompanied by great longing for change, and not infrequently with revulsion from previous effort. The naturalist who has devoted a part of his life to the persistent accumulation of facts and specimens, has held the imaginative and generalizing powers in abeyance during that period. The reserve brain-force in this direction may be suddenly called into activity by exhaustion in the other, and the process may perhaps be comparable to the exhaustion of the soil for one particular crop, without lessening its fertility for some other, the recognition of which fact is the foundation of all successful agriculture. Excess of development, whether in body or mind, inevitably brings about either wholesome reaction or utter collapse.

How far the rhythmic tendency in the development of animal life may be explained by the rapid change of climate, by migration and the loss of record, or upon the general law that while there has been progress of the whole, there has not necessarily been progress of every part, it would take us too far to discuss in this connection. I think we are safe in saying, however, that the facts justify the belief that, in the evolution of animal life, as in the evolution of everything else, progress has often been made by waves.

Fiske's Law.—With regard to what may be called Fiske's law of correlation between brain development and infantile dependency, Fiske has so admirably elaborated the subject that it

needs no further elucidation here as the principal factor in the evolution in man, first of the family relation, then of the clan, the tribe, and the nation. With this factor in mind, and the immense superiority which anthropoid man must have had, when brain development had once induced this fundamental community of interest over the rest of brute creation, the gap between primitive man and the higher anthropoid apes in the past, or between the present lower races of man and the higher existing primates, is easily explained, even if it had not been greatly exaggerated. At the present time we may note and record the further inevitable increase in the gap, for the lower races of man are gradually becoming extinct, and the higher apes can not long hold their own or persist.

Brooks's Hypothesis.—I have already alluded to Brooks's hypothesis under the head of sexual differentiation, and his work on heredity must be so familiar to you that his views need but a passing notice. He believes that sex differentiation means fundamentally a physiological division of labor, and that the male is essentially the progressive or diversifying and the female the conservative agent. As organisms gradually increased in size, as the number of cells in their bodies became greater, and as the differentiation and specialization of these cells became more and more marked, one element, the male cell, became adapted for storing up gemmules, and, at the same time, gradually lost its unnecessary and useless power to transmit hereditary characteristics.

The theory finds support in some of the phenomena of life, and doubtless expresses a law not easily established, for which reason it will not be readily accepted. It leaves entirely out of consideration some of the forces at work which I have already indicated, and in so far must be considered only a law of secondary importance. However much we may admit the general truth that the germ-cell continues the past and the sperm-cell tends to diverge from it, as a purely dynamic proposition, inducing variation for natural selection to play upon, it does not in any way decrease the overwhelming importance of the female in inducing, through psychico-physiological influences, a needed and purposeful modification in the manner which I have already expounded.

THE probable character of the language of palæolithic man is the subject of one of Dr. Brinton's latest studies. Taking some very primitive American languages as his guide, he concludes that it was more rudimentary than any language known to us; that it had no grammatical form or fixed phonetic values, but depended largely upon gesture, tone, and stress; that its words often had antithetic meanings, which could only be determined from the accent or sign; and that the different vowel-sounds and consonantal groups conveyed specific significance, and were of more import than the syllables which they formed.

CURIOSITIES OF NATURAL GAS.

By Prof. JOSEPH F. JAMES, M. S.

IT is but little more than four years since there appeared, among the economical products of Ohio and Indiana, a new force, which has worked a sort of revolution among manufactures. The geographies used to say Ohio was noted for wheat, corn, and pork; now they must add petroleum and natural gas.

Rock-oil, or petroleum, has long been known to the world at large. So, too, has natural gas. The former was the early pioneer's panacea. So precious was it that it was soaked up from the ground by blankets, and was then wrung out and preserved for times of need. The latter was and is still dreaded by miners as the deadly "fire-damp." It was known to the Chinese long years ago, and wells three thousand feet deep, giving off great volumes of the material, were not uncommon. Burning springs had been found in Virginia in 1775, and were well known in the valley of the Kanawha River in the early part of this century. Fredonia, in New York State, was lighted by natural gas in 1824; while immense quantities of the precious fuel were at a later period, and before its great value had become recognized, wasted in the oil regions of Pennsylvania.

Notwithstanding these facts, no one suspected that there lay, concealed a thousand feet deep in the soil of Ohio and Indiana, such a wonderful source of power as has been discovered. Those who first sought for it were designated by the usual and familiar appellations of fools and cranks, just as the originators of the telephone, the telegraph, the locomotive, and the steam-engine had been before them. Recent events have proved the wisdom of the pioneers in the new field, and now portions of Ohio and Indiana are famous the world over as reservoirs of that wonderful product of Nature's laboratory, natural gas.

The excitement which followed the announcement of the discovery of natural gas at Findlay, Ohio, was like that following the discovery of gold in California—with this exception, that whereas the gold-fields were to be sought for in a far-away country, the gas was to be had at our very doors. The earth had but to be penetrated a few hundred or a thousand feet, and there was the equivalent of a gold-mine; at least, so it was imagined, and, with this idea firmly implanted, every little town within a radius of a hundred miles of Findlay, and even further away, determined to have some of the precious fuel. Experience has demonstrated that the thing can not be had for the asking in every locality. It has been shown that only where certain conditions of the rocky

strata of the earth exist, is the gas likely to be present in any quantity; and that outside of where these conditions obtain it is useless to expend money in sinking wells.

The busy operations thus inaugurated were watched by scientific men with great interest. A new horizon for the gas was the point which especially attracted their attention, for the fuel came from a stratum far below those belts which had in Pennsylvania and Virginia produced the gas and oil. Besides, to the geologist was promised an opportunity of increasing his knowledge of the arrangement of certain strata beneath the surface, whose course *at* the surface had long been known. The geologist knew that, even when the attempt to secure gas was unavailing there was a possibility of the dry well revealing to him a new chapter in the story of the rocks.

The practical man, for his part, looked upon the new fuel with an eye to its utilization. By lessening the cost of production, it increased his profits, if indeed increased competition did not keep the price down in proportion. A dry well was to these men a calamity, for it brought them in nothing for their outlay.

With a third class the new fever opened up a field of speculation, of which they were not slow to avail themselves. Theorists are ever ready to thrust upon a patient world their views, even though the chances of formulating a correct theory are small. The origin of the gas has, therefore, formed a fruitful source of speculation with these persons. Some of the causes assigned are so supremely ridiculous as to deserve notice as psychological curiosities. Two or three of these crude theories will occupy but a few moments.

One writer asks whether it is safe to bore the earth too much. He assumes the earth to be a hollow sphere filled with a gaseous substance called by us natural gas, and he thinks that tapping these reservoirs will cause disastrous explosions, resulting from the lighted gas coming in contact with that which is escaping. Earthquakes, he says, are probably caused by vacuums created by the outflowing gas. He compares the earth to a balloon floated and kept distended by the gas in the interior, which, if exhausted, will cause the crust to collapse, affect the motion of the earth in its orbit, cause it to lose its place among the heavenly bodies, and fall in pieces. He thinks man is too inquisitive; he wants to peer into the earth too far. But let him beware. Children should not be allowed to handle explosives, nor should ignorant man meddle with natural gas. "Let the matter be fully investigated by able, God-fearing men—men who believe in the Bible as well as geology"—and all may yet be well.

Another writer thinks that boring should be prohibited by

stringent laws. He, too, thinks there is a possibility of an explosion, though from another cause. For, did not the same craze possess China two centuries ago? Were not wells bored in great numbers, and was not the escaping gas ignited? So much so, indeed, that finally one huge well sucked down the fiery volume of a smaller one into its own aperture, and a violent explosion ensued which destroyed thousands of people. A similar catastrophe he considers imminent in Ohio and Indiana. Should such a disaster occur, "the country along the gas-belt from Toledo through Ohio, Indiana, and Kentucky will be ripped up to the depth of twelve or fifteen hundred feet, and flopped over like a pancake, leaving a chasm through which the waters of Lake Erie will come howling down, filling the Ohio and Mississippi Valleys, and blotting them out forever"! Prompt action should be taken. The Governor should call a special session of the Legislature, and the President a special session of Congress, to enact laws to protect the nation against "destruction from natural gas."

Another, called an experienced miner, gone wild over his ignorance in regard to the Trenton limestone—words in everybody's mouth—says that probably the "so-called Trenton limestone is nothing but an incident found about already successful gas-wells. It probably came out of the rift the same as other materials. It is found in the Colorado mines, and is called by the miners bastard quartz"! Such geological knowledge requires no comment.

Still another theorist has investigated the gas-wells with telephones and delicate thermometers, and he announces startling discoveries. He distinguished sounds like the boiling of rocks, and estimated that a mile and a half or so beneath Findlay the temperature of the earth is 3,500°. This scientist says an immense cavity exists under Findlay, and that here the gas is stored; that a mile below the bottom of the cavity is a mass of roaring, seething flame, which is gradually eating into the rocky floor of the cavern and thinning it. Eventually the flames will reach the gas, a terrific explosion will ensue, and Findlay and its neighborhood will be blown skyward in an instant. Such are some of the theories gravely propounded in respect to this new fuel. The effects of the *use* of the fuel are almost as wonderful as the theories of its origin.

In the year 1884 the town of Findlay, Ohio, had a population of about 4,500. In the spring of that year Dr. Charles Oesterlin, who had for years been a firm believer in the existence of quantities of natural gas in and about the town, induced some friends to join him in forming a stock-company to bore for gas. Work was not begun until near the end of October, but in the course of time a well was sunk to a depth of 1,092 feet. At this depth a reser-

voir of gas was tapped, the like of which had not been dreamed of before. A new era had opened for Findlay. The blaze from the lighted stand-pipe shot up twenty or thirty feet in the air. The light could be seen twenty-five or thirty miles away in all directions. The amount of gas given off daily was estimated at about 250,000 cubic feet. People flocked from far and near to see the wonderful sight. Other wells were, of course, immediately begun, the most of them being successful. In December, 1885, the largest well of the field was drilled in, and from a depth of 1,144 feet came the gas of the great Karg well. The roar of this could be heard two or three miles, while its light was visible thirty-five or forty miles on all sides. Its flow was estimated at over 12,000,000 cubic feet per day. It has proved to be Findlay's standing advertisement, and it has been a sign which says to many, "Natural gas has come to stay."

The town began to grow as soon as the first well had proved a success. From 4,500, in 1884, it had grown to 6,000 in January, 1886. In the spring of 1887 a speculative fever broke out, which affected the whole State. From a town originally four square miles in extent, Findlay has grown to twenty-four square miles area. From a population of 6,000, in 1886, it had grown to 10,000 in the spring of 1887. In September of the same year the population was estimated at from 13,000 to 18,000, and at that time it was calculated its people would number 30,000 in the early part of 1888. The value of real estate rose rapidly; two, three, even five times its previous value was given for land. Farms which had been held at $100 per acre changed hands at $300 per acre and over. These acres were divided into lots, and greedily bought by speculators at so much per foot. Real estate to the value of over $300,000 has changed hands in a single day.

This speculative fever caused a wonderful activity while it lasted. The offer of plots of ground and of free gas brought an influx of manufactories of all kinds. Seven hundred houses were built during the first half of 1887, and as many more were under contract to be finished before the end of the year. Glass-factories, rolling-mills, iron and steel works, furniture-factories, brick-yards, lime-kilns, and many other branches of trade, have been successfully established. The gas company, which had previously to the new discovery supplied the town with artificial gas, secured numerous wells of their own, among them the Karg well, and established a new scale of prices. But the citizens complained about the rates, succeeded in inducing the Legislature to allow them to issue bonds for $60,000 to supply their own gas, and soon so reduced the price that the gas company sold out to the city. The rates had then been cut to only fifteen cents a month for either a cooking or a heating stove; it is now stated to be fur-

nished free of cost to the citizens (*vide* circular of the Chamber of Commerce).

No sooner had Findlay added natural gas to her attractive features than every town in the vicinity determined to seek for the fuel. The soil of Ohio and Indiana has been bored full of holes in this search. Many places have been successful, more have failed; for, as Dr. Orton says:* "Every county in the western half of Ohio, without exception, has already drilled one or more wells to the Trenton limestone, or at least has made a vigorous and determined effort to reach the new source of light and heat. Many counties outside this limit have spent and are still spending money lavishly in the same search. Even small villages, that have heretofore counted themselves too poor to provide such fundamental requirements of comfortable living as sidewalks, street-lamps, and graveled roadways, find no trouble in raising money enough to drill two thousand feet, or more, into the underlying rocks, in search for natural gas. When such towns attain any pronounced success in their drilling, they are sometimes temporarily embarrassed thereby, as there are, in many cases, no industries established in them to which a large flow of gas can be profitably applied."

The amount of gas given off from the numerous successful wells in the new fields in Ohio and Indiana is incredible. Findlay itself is estimated to possess a supply of 60,000,000 cubic feet per day. Bowling Green has several wells which yield over 900,000 cubic feet per day. Muncie, Indiana, with seven wells, is calculated to have 6,000,000 cubic feet a day. Noblesville has one well yielding about 2,000,000 cubic feet, and so on for a long list. Probably at least 100,000,000 cubic feet a day would be the yield of the wells which are now productive in this territory.

Where all this is occurring, it is a matter of vital importance to ascertain whether the supply will be a lasting one. There is little doubt but that it is a stored force, and, when once exhausted, as it must rapidly be, there will be no new supply. Yet the waste which goes on is simply appalling. Some of the wells burned for months before they were controlled or utilized. Almost every new well, wherever found, is lighted and allowed to burn at the rate of from 200,000 to 2,000,000 cubic feet per day, often for weeks. It is stated † that for several months of 1886 no less than 18,000,000 cubic feet of gas were burned in or about Findlay every day. The Karg well alone, it is estimated, caused a loss to the field of 150,000,000 cubic feet of this precious fuel. Now, it is true, there is less of this wanton waste going on. Owners of wells and others who are interested have come to see the importance

* "Ohio Geology," vol. vi, p. 117. † Ibid., p. 133.

of husbanding this valuable product, and there is less and less waste every day. Indeed, it behooves all to be careful, for, with the exhaustion of the gas, the improvements, the factories, the towns themselves will vanish.

PLANTS IN WITCHCRAFT.*

By T. F. THISELTON DYER.

THE vast proportions which the great witchcraft movement assumed in by-gone years explains the magic properties which we find ascribed to so many plants in most countries. In the nefarious trade carried on by the representatives of this cruel system of sorcery certain plants were largely employed for working marvels, hence the mystic character which they have ever since retained. It was necessary, however, that these should be plucked at certain phases of the moon or seasons of the year, or from some spot where the sun was supposed not to have shone on it.† Hence Shakespeare makes one of his witches speak of "root of hemlock digg'd i' the dark," and of "slips of yew sliver'd in the moon's eclipse," a practice which was long kept up. The plants, too, which formed the witches' pharmacopœia, were generally selected either from their legendary associations or by reason of their poisonous and soporific qualities. Thus, two of those most frequently used as ingredients in the mystic caldron were the vervain and the rue, these plants having been specially credited with supernatural virtues. The former probably derived its notoriety from the fact of its being sacred to Thor, an honor which marked it out, like other lightning plants, as peculiarly adapted for occult uses. It was, moreover, among the sacred plants of the Druids, and was only gathered by them, "when the dog-star arose, from unsunned spots." At the same time, it is noteworthy that many of the plants which were in repute with witches for working their marvels were reckoned as counter-charms, a fact which is not surprising, as materials used by wizards and others for magical purposes have generally been regarded as equally efficacious if employed against their charms and spells.‡ Although vervain, therefore, as the "enchanters' plant," was gathered by witches to do mischief in their incantations, yet, as Aubrey says, it "hinders witches from their will," a circumstance to which Drayton further refers when he speaks of the vervain as "'gainst witchcraft much avayling." Rue, likewise, which entered so largely into magic rites, was once much in request as an antidote against such prac-

* From "The Folk-Lore of Plants," in the press of D. Appleton & Co.

† See Moncure Conway's "Demonology and Devil-Lore," 1880, ii, 324.

‡ See Friend's "Flower-Lore," ii, 529, 530.

tices; and nowadays, when worn on the person in conjunction with agrimony, maiden-hair, broom-straw, and ground-ivy, it is said in the Tyrol to confer fine vision, and to point out the presence of witches.

It is still an undecided question as to why rue should out of all other plants have gained its wide-spread reputation with witches, but M. Maury supposes that it was on account of its being a narcotic and causing hallucinations. At any rate, it seems to have acquired at an early period in England a superstitious reverence, for, as Mr. Conway says,* "we find the missionaries sprinkling holy water from brushes made of it, whence it was called 'herb of grace.'"

Respecting the rendezvous of witches, it may be noted that they very frequently resorted to hills and mountains, their meetings taking place "on the mead, on the oak sward, under the lime, under the oak, at the pear-tree." Thus the fairy rings which are often to be met with on the Sussex downs are known as hag-tracks,† from the belief that "they are caused by hags and witches, who dance there at midnight."‡ Their love for sequestered and romantic localities is widely illustrated on the Continent, instances of which have been collected together by Grimm, who remarks how "the fame of particular witch-mountains extends over wide kingdoms." According to a tradition current in Friesland,* "no woman is to be found at home on a Friday, because on that day they hold their meetings and have dances on a barren heath." Occasionally, too, they show a strong predilection for certain trees, to approach which as night-time draws near is considered highly dangerous. The Judas-tree (*Cercis siliquastrum*) was one of their favorite retreats, perhaps on account of its traditionary association with the apostle. The Neapolitan witches held their tryst under a walnut-tree near Benevento,‖ and at Bologna the peasantry tell how these evil workers hold a midnight meeting beneath the walnut-trees on St. John's Eve. The elder-tree is another haunt under whose branches witches are fond of lurking, and on this account caution must be taken not to tamper with it after dark.^ Again, in the Netherlands, experienced shepherds are careful not to let their flocks feed after sunset, for there are wicked elves that prepare poison in certain plants—nightwort being one of these. Nor does any man dare to sleep in a meadow or pasture after sunset, for, as the shepherds say, he would have everything to fear.

* "Demonology and Devil-Lore," ii, 324.
† Grimm, "Teutonic Mythology," 1883, iii, 1051.
‡ Folkard's "Plant Lore, Legends, and Lyrics," 1884, p. 91.
* Thorpe's "Northern Mythology," iii, 19.
‖ Grimm's "Teutonic Mythology," iii, 1052.
^ See Thorpe's "Northern Mythology," iii, 267.

A Tyrolese legend* relates how a boy who had climbed a tree "overlooked the ghastly doings of certain witches beneath its boughs. They tore in pieces the corpse of a woman, and threw the portions in the air. The boy caught one, and kept it by him; but the witches, on counting the pieces, found that one was missing, and so replaced it by a scrap of alder-wood, when instantly the dead came to life again."

Similarly, also, they had their favorite flowers, one having been the foxglove, nicknamed "witches' bells," from their decorating their fingers with its blossoms; while in some localities the harebell is designated the "witches' thimble." On the other hand, flowers of a yellow or greenish hue were distasteful to them.†

In the witchcraft movement it would seem that certain plants were in requisition for particular purposes, these workers of darkness having utilized the properties of herbs to special ends. A plant was not indiscriminately selected, but on account of possessing some virtue as to render it suitable for any design that the witches might have in view. Considering, too, how multitudinous and varied were their actions, they had constant need of applying to the vegetable world for materials with which to carry out their plans. But foremost among their requirements was the power of locomotion wherewith to enable them, with supernatural rapidity, to travel from one locality to another. Accordingly, one of their most favorite vehicles was a besom or broom, an implement which, it has been suggested, from its being a type of the winds, is an appropriate utensil "in the hands of the witches, who are wind-makers and workers in that element."‡ According to the "Asiatic Register" for 1801, the Eastern as well as the European witches "practice their spells by dancing at midnight, and the principal instrument they use on such occasions is a broom." Hence, in Hamburg, sailors, after long toiling against a contrary wind, on meeting another ship sailing in an opposite direction, throw an old broom before the vessel, believing thereby to reverse the wind.* As, too, in the case of vervain and rue, the besom, although dearly loved by witches, is still extensively used as a counter-charm against their machinations—it being a well-known belief both in England and Germany that no individual of this stamp can step over a besom laid inside the threshold. Hence, also, in Westphalia, at Shrovetide, white besoms with white handles are tied to the cows' horns; and, in the rites connected with the midsummer fires kept up in different parts of the country, the besom holds a prominent place. In Bo-

* See Folkard's "Plant Lore, Legends, and Lyrics," p. 209. † Ibid., p. 104.

‡ See Kelly's "Indo-European Folk-Lore," pp. 225–227.

* See Hardwick's "Traditions, Superstitions, and Folk-Lore," p. 117; also Grimm's "Teutonic Mythology," 1883, iii, 1083.

hemia, for instance, the young men collect for some weeks beforehand as many worn-out brooms as they can lay their hands on. These, after dipping in tar, they light—running with them from one bonfire to another—and when burned out they are placed in the fields as charms against blight.* The large ragwort—known in Ireland as the "fairies' horse"—has long been sought for by witches when taking their midnight journeys. Burns, in his "Address to the Deil," makes his witches "skim the muirs and dizzy crags" on "rag-bred nags" with "wicked speed." The same legendary belief prevails in Cornwall, in connection with the Castle Peak, a high rock to the south of the Logan stone. Here, writes Mr. Hunt,† "many a man and woman too, now quietly sleeping in the churchyard of St. Levan, would, had they the power, attest to have seen the witches flying into the Castle Peak on moonlight nights, mounted on the stems of the ragwort." Among other plants used for a similar purpose were the bulrush and reed, in connection with which may be quoted the Irish tale of the rushes and cornstalks that "turn into horses the moment you bestride them."‡ In Germany* witches were said to use hay for transporting themselves through the air.

When engaged in their various occupations they often considered it expedient to escape detection by assuming invisibility, and for this object sought the assistance of certain plants, such as the fern-seed. In Sweden, hazel-nuts were supposed to have the power of making invisible, and it may be remembered how, in one of Andersen's stories, the elfin princess has the faculty of vanishing at will by putting a wand in her mouth.‖ But these were not the only plants supposed to confer invisibility, for German folk-lore tells us how the far-famed luck-flower was endowed with the same wonderful property; and by the ancients the heliotrope was credited with a similar virtue, but which Boccaccio, in his humorous tale of Calandrino in the "Decameron," applies to the so-called stone: "Heliotrope is a stone of such extraordinary virtue that the bearer of it is effectually concealed from the sight of all present." Dante, in his "Inferno," xxiv, 92, further alludes to it:

> "Amid this dread exuberance of woe
> Ran naked spirits winged with horrid fear,
> Nor hope had they of crevice where to hide,
> Or heliotrope to charm them out of view."

In the same way, the agate was said to render a person in-

* See Thorpe's "Northern Mythology," 1852, iii, 21, 137.
† "Popular Romances of the West of England," 1871, p. 330.
‡ Grimm's "Teutonic Mythology," iii, 1084.
* See Thorpe's "Northern Mythology," iii, 208, 209.
‖ See Yardley's "Supernatural in Romantic Fiction," 1880, pp. 131, 132.

visible, and to turn the swords of foes against themselves.* The Swiss peasants affirm that the Ascension-Day wreaths of the amaranth make the wearer invisible, and in the Tyrol the mistletoe is credited with this property.

But some plants, as we have already pointed out, were credited with the magic property of revealing the presence of witches, and of exposing them engaged in the pursuit of plying their nefarious calling. In this respect the St. John's wort was in great request, and hence it was extensively worn as an amulet, especially in Germany on St. John's Eve, a time when not only witches by common report peopled the air, but evil spirits wandered about on no friendly errand. Thus the Italian name of "devil-chaser," from the circumstance of its scaring away the workers of darkness, by bringing their hidden deeds to light. This, moreover, accounts for the custom so prevalent in most European countries of decorating doorways and windows with its blossoms on St. John's Eve.

But, in spite of plants of this kind, witches somehow or other contrived to escape detection by the employment of the most subtle charms and spells. They generally, too, took the precaution of avoiding such plants as were antagonistic to them, displaying a cunning ingenuity in most of their designs which it was by no means easy to forestall. Hence in the composition of their philters and potions they infused the juices of the most deadly herbs, such as that of the nightshade or monk's-hood; and to add to the potency of these baleful draughts they considered it necessary to add as many as seven or nine of the most poisonous plants they could obtain, such, for instance, as those enumerated by one of the witches in Ben Jonson's "Masque of Queens," who says:

> "And I ha' been plucking plants among
> Hemlock, henbane, adder's tongue;
> Nightshade, moonwort, libbard's bane,
> And twice, by the dogs, was like to be ta'en."

Another plant used by witches in their incantations was the sea or horned poppy, known in mediæval times as *Ficus infernalis;* hence it is further noticed by Ben Jonson in the "Witches' Song":

> "Yes, I have brought to help our vows,
> Horned poppy, cypress-boughs,
> The fig-tree wild that grows on tombs,
> And juice that from the larch-tree comes."

Then, of course, there was the wondrous moonwort (*Botrychium lunaria*), which was doubly valuable from its mystic virtue, for,

* See Fiske, "Myths and Mythmakers," p. 44; also Baring-Gould's "Curious Myths of the Middle Ages," 1877, p. 398.

as Culpepper* tells us, it was believed to open locks and possess other magic virtues. The mullein, popularly termed the hag-taper, was also in request, and the honesty (*Lunaria biennis*), "in sorceries excelling," was equally employed. By Scotch witches the woodbine was a favorite plant,† who, in effecting magical cures, passed their patients nine times through a girth or garland of green woodbine.

Again, a popular means employed by witches of injuring their enemies was by the bryony. Coles, in his "Art of Simpling," for instance, informs us how "they take likewise the roots of mandrake, according to some, or, as I rather suppose, the roots of briony, which simple folk take for the true mandrake, and make thereof an ugly image, by which they represent the person on whom they intend to exercise their witchcraft." And Lord Bacon, speaking of the mandrake, says: "Some plants there are, but rare, that have a mossie or downy root, and likewise that have a number of threads, like beards, as mandrakes, whereof witches and impostours make an ugly image, giving it the form of a face at the top of the root, and leave those strings to make a broad beard down to the foot." The witchcraft literature of the sixteenth and seventeenth centuries contains numerous allusions to the diabolical practice—a superstition immortalized by Shakespeare. The mandrake, from its supposed mysterious character, was intimately associated with witches, and Ben Jonson, in his "Masque of Queens," makes one of the hags who has been gathering this plant say:

> "I last night lay all alone
> On the ground, to hear the mandrake groan;
> And plucked him up, though he grew full low,
> And, as I had done, the cock did crow."

We have already incidentally spoken of the vervain, St. John's wort, elder, and rue as antagonistic to witchcraft, but to these may be added many other well-known plants, such as the juniper, mistletoe, and blackthorn. Indeed, the list might be greatly extended—the vegetable kingdom having supplied in most parts of the world almost countless charms to counteract the evil designs of these malevolent beings. In England the little pimpernel, herb-paris, and cyclamen were formerly gathered for this purpose, and the angelica was thought to be specially noisome to witches. The snapdragon and the herb-betony had the reputation of averting the most subtle forms of witchcraft, and dill and flax were worn as talismans against sorcery. Holly is said to be antagonistic to witches, for, as Mr. Folkard‡ says, "in its name

* "British Herbal." † See Folkard's "Plant Lore, Legends, and Lyrics," p. 380.
‡ "Plant Lore, Legends, and Lyrics," p. 376.

they see but another form of the word 'holy,' and its thorny foliage and blood-red berries are suggestive of the most Christian associations." Then there is the rowan-tree or mountain-ash, which has long been considered one of the most powerful antidotes against works of darkness of every kind, probably from its sacred associations with the worship of the Druids. Hence it is much valued in Scotland, and the following couplet, of which there are several versions, still embodies the popular faith:

"Rowan-tree and red thread
Put the witches to their speed."

But its fame has not been confined to any one locality, and as far south as Cornwall the peasant, when he suspects that his cow has been "overlooked," twists an ashen twig round its horns. Indeed, so potent is the ash as a counter-charm to sorcery, that even the smallest twig renders their actions impotent; and hence, in an old ballad entitled "Laidley Wood," in the "Northumberland Garland," it is said:

"The spells were vain, the hag returned
To the queen in sorrowful mood,
Crying that witches have no power
Where there is row'n-tree wood."

Hence persons carry an ashen twig in their pocket, and according to a Yorkshire proverb—

"If your whipstick's made of row'n,
You may ride your nag through any town";

but, on the other hand, "Woe to the lad without a rowan-tree gall!" Possessed of such virtues, it is not surprising that the mystic ash should have been held in the highest repute, in illustration of which we find many an amusing anecdote. Thus according to a Herefordshire tradition, some years ago two hogsheads full of money were concealed in an underground cellar belonging to the Castle of Penyard, where they were kept by supernatural force. A farmer, however, made up his mind to get them out, and employed for the purpose twenty steers to draw down the iron door of the vault. On the door being slightly opened, a jackdaw was seen sitting on one of the casks, but the door immediately closed with a bang—a voice being heard to say:

"Had it not been
For your quicken-tree goad,
And your yew-tree pin,
You and your cattle
Had all been drawn in."

Another anecdote current in Yorkshire is interesting, showing how fully superstitions of this kind are believed:* "A woman

* Henderson's "Folk-Lore of Northern Counties," 1879, p. 225.

was lately in my shop, and in pulling out her purse brought out also a piece of stick a few inches long. I asked her why she carried that in her pocket. 'Oh,' she replied, 'I must not lose that, or I shall be done for.' 'Why so?' I inquired. 'Well,' she answered, 'I carry that to keep off the witches; while I have that about me, they can not hurt me.' On my adding that there were no witches nowadays, she instantly replied: 'Oh, yes! there are thirteen at this very time in the town, but so long as I have my rowan-tree safe in my pocket they can not hurt me.'"

Occasionally when the dairy-maid churned for a long time without making butter, she would stir the cream with a twig of mountain-ash, and beat the cow with another, thus breaking the witch's spell. But, to prevent accidents of this kind, it has long been customary in the northern counties to make the churn-staff of ash. For the same reason herd-boys employ an ash-twig for driving cattle, and one may often see a mountain-ash growing near a house. On the Continent the tree is in equal repute, and in Norway and Denmark rowan-branches are usually put over stable-doors to keep out witches, a similar notion prevailing in Germany. No tree, perhaps, holds such a prominent place in witchcraft-lore as the mountain-ash, its mystic power having rarely failed to render fruitless the evil influence of these enemies of mankind.

Lastly, to counteract the spell of the evil eye, from which many innocent persons were believed to suffer in the witchcraft period, many flowers have been in requisition among the numerous charms used. Thus, the Russian maidens still hang round the stem of the birch-tree red ribbon, the Brahmans gather rice, and in Italy rue is in demand. The Scotch peasantry pluck twigs of the ash, the Highland women the groundsel, and the German folk wear the radish. In early times the ringwort was recommended by Apuleius, and later on the fern was regarded as a preservative against this baneful influence. The Chinese put faith in the garlic; and, in short, every country has its own special plants. It would seem, too, that after a witch was dead and buried, precautionary measures were taken to frustrate her baneful influence. Thus, in Russia, aspen is laid on a witch's grave, the dead sorceress being then prevented from riding abroad.

THE first mention of a canal to unite the oceans was made—to assert its impossibility—by an old Spanish historian, P. Acosta, who said, in 1588, that "no human power would be sufficient to cut through the strong and impenetrable bonds which God has put between the two oceans of mountains and iron rocks"; and he added, "If it were possible, it would appear to me to be very just to fear the vengeance of Heaven for attempting to improve the works which the Creator, in his almighty will and providence, ordered from the creation of the world."

SKETCH OF JAMES POLLARD ESPY.

METEOROLOGY is one of the youngest of the sciences. Most of what is settled and systematized has been developed within the memory of men who are still living. The contributions of Americans to research in this branch have been among the most important. Among the earlier labors in this field none deserve or have received wider recognition than those of Prof. Espy. He may, indeed, be regarded with justice as the founder of the science as at present cultivated in relation to storm predictions.

JAMES P. ESPY was born in Westmoreland County, Pa., May 9, 1785, and died in Cincinnati, Ohio, January 24, 1860. While he was still an infant his father moved to the Blue Grass region of Kentucky; but, on finding the institution of slavery antagonistic to the principles inherited from his Huguenot ancestry, he removed after a few years to the Miami Valley in Ohio. One of his daughters had in the mean time married a Kentuckian of Mount Sterling, and James, remaining with this sister for the sake of the opportunity, became, at eighteen years of age, a student in Transylvania University, at Lexington. Here he was visited in 1805 by an elder brother, who was engaged in the practice of the law in Pennsylvania, who wrote of him: "I met my brother James, whom I had not seen since he was an infant. I found him at the university, where he had made considerable progress in the dead languages and in general science. He shows an ardent desire for knowledge, and promises to be both intelligent and useful." He was graduated in 1808, and went to Xenia, Ohio, where he taught school and studied law. Of this part of his career, Mrs. L. M. Morehead, his niece, in her "Few Incidents"* of his life, says that "his love for teaching amounted to enthusiasm, and, although he completed his law studies, he finally abandoned the idea of choosing the law as his profession, and determined to follow the bent of his inclination, and become a conscientious instructor of youth." To his latest years "he considered this a noble profession, and even in old age was fond of drawing out young students to talk over their lessons with him, both hearing them and asking them questions." Either before or after this—the authorities differ—he filled creditably and satisfactorily the position of principal of the academy at Cumberland, Md., where he married Miss Margaret Pollard, who afterward gave him her full sympathy and encouragement in his meteorological researches.

In 1817 Mr. Espy became a teacher in the classical department of the Franklin Institute, a position in which, according to the

* "A Few Incidents in the Life of Professor James P. Espy, by his Niece, Mrs. L. M. Morehead," Cincinnati, Robert Clarke & Co.

late Prof. A. D. Bache, he became known as "one of the best classical and mathematical instructors in Philadelphia, which at that day numbered Dr. Wylie, Mr. Sanderson, and Mr. Crawford among its teachers. Impressed by the researches and writings of Dalton and of Daniell on meteorology," Prof. Bache continued, in a eulogy before the Regents of the Smithsonian Institution, "Mr. Espy began to observe the phenomena and then to experiment on the facts which form the groundwork of the science. As he observed, experimented, and studied, his enthusiasm grew, and his desire to devote himself exclusively to the increase and diffusion of the science finally became so strong that he determined to give up his school, and to rely for the means of prosecuting his researches upon his slender savings and the success of his lectures, probably the most original which have ever been delivered on this subject. His first course was delivered before the Franklin Institute of Pennsylvania, of which he had long been an active member, and where he met kindred spirits, ready to discuss the principles or the applications of science, and prepared to extend their views over the whole horizon of physical and mechanical research. As chairman of the Committee on Meteorology, Mr. Espy had a large share in the organization of the complete system of meteorological observations carried on by the Institute under the auspices and within the limits of the State of Pennsylvania." Mrs. Morehead quotes from the account of a friend who visited him in Philadelphia a description of Prof. Espy's method of pursuing his atmospheric calculations, which necessarily had to be carried on out of doors. The high fence inclosing the small yard was of smooth plank, painted white, while the space inclosed was filled with vessels of water and numerous thermometers for determining the dew-point. The white fence, when last seen by the narrator, was so covered with figures and calculations that not a spot remained for another sum or column. Prof. Espy's theory of storms was first developed in successive memoirs in the "Journal of the Franklin Institute," containing discussions of the changes of temperature, pressure, and moisture of the air, and of the direction and force of the wind, and other phenomena attending remarkable storms in the United States and on the ocean adjacent to the Atlantic and Gulf coast. "Assuming great simplicity," says Prof. Bache, "as it was developed, and founded on the established laws of physics, and upon ingenious and well-directed experiments, this theory drew general attention to itself, especially in the United States. A memoir submitted anonymously to the American Philosophical Society of Philadelphia gained for Mr. Espy the award of the Magellanic premium in the year 1836, after a discussion remarkable for ingenuity and closeness in its progress, and for the almost perfect unanimity of its result."

In 1840 Prof. Espy, by invitation, visited England for the purpose of explaining his theory of storms before the British Association. He presented it, in an elaborate paper, in September, 1840, Prof. Forbes being the presiding officer of the meeting, after which it was subjected to a lively discussion, in which some of the most eminent British scientific men of the day took part, some sustaining it, and some presenting objections to it. He afterward visited Paris, and presented a communication to the Academy of Sciences. The committee to whom the communication was referred, consisting of MM. Arago, Pouillet, and Babinet, at the conclusion of their report, admitted that the memoir "contains a great number of well-observed and well-described facts. His theory in the present state of science alone accounts for the phenomena, and when completed, as Mr. Espy intends, by the study of the action of electricity when it intervenes, will leave nothing to be desired. In a word, for physical geography, agriculture, navigation, and meteorology, it gives us new explanations, indications useful for ulterior researches, and redresses many accredited errors. The committee expresses, then, the wish that Mr. Espy may be placed by the Government of the United States in a position to continue his important investigations, and to complete his theory, already so remarkable, by means of all the observations and all the experiments which the deductions even of his theory may suggest to him in a vast country, where enlightened men are not wanting to science, and which is, besides, the home of those fearful storms. The work of Mr. Espy causes us to feel the necessity of undertaking a retrospective examination of the numerous documents already collected in Europe, to arrange them, and draw from them deductions which they can furnish, and more especially at the present period, when the diluvial rains which have ravaged the southeast of France have directed attention to all the possible causes of similar phenomena. Consequently, the committee proposes to the Academy to give its approbation to the labors of Mr. Espy, and to solicit him to continue his researches, and especially to try to ascertain the influence which electricity exerts in these great phenomena, of which a complete theory will be one of the most precious acquisitions of modern science."

This report was incorporated in full in the introduction to "The Philosophy of Storms"—"not merely," as the author says with characteristic independence of opinion, "for the purpose of showing the reader that I have the highest authority on my side—for I do not submit to authority myself—but to exhibit a beautiful analysis of my theory by three of the most distinguished philosophers in Europe. As a matter of authority, however, I should be justified in bringing forward the report to rebut authority. It had been sneeringly said before a large audience, by

a distinguished professor, that I had failed to convince men of science of the truth of my theory, and that I had appealed to the people, who are incapable of judging. It became, therefore, necessary to obtain authority against authority."

The origin of the studies upon which the theory of storms is based is traced in the opening paragraph of the "Philosophy" to the result described by Dalton, that the quantity of vapor in weight, existing at any time in a given place, could be determined by means of a thermometer and a tumbler of water cold enough to condense on its outside a portion of the vapor in the air. "It occurred to me at once," Prof. Espy says, "that this was the lever with which the meteorologist was to move the world. I immediately commenced the study and examination of atmospheric phenomena, determined to discover, if possible, what connection there is between rain and the quantity of vapor in the atmosphere." Prof. Espy prefaced his paper in the British Association by saying that he had found, by examining simultaneous observations in the middle of storms and all round their borders, that the wind blows inward on all sides of a storm toward its central parts; toward a point if the storm is round, and toward a line if the storm is oblong, extending through its longest diameter. The theory is, in brief, that every atmospheric disturbance begins with the ascension of air that has been rarefied by heat. The rising mass dilates, and, as its temperature falls, precipitates vapor in the form of clouds. Owing to the liberation of the latent heat, the dilatation continues with the rising till the moisture of the air forming the upward current is practically exhausted. The heavier air flows in beneath, and, finding a diminished pressure above it, rushes upward with constantly increasing violence. The great quantity of aqueous vapor precipitated during this atmospheric disturbance gives rise to heavy rains. Much of this theory still holds good; but it has been found that the motion of the wind in storms is rotary.

Besides his explanation and proofs of this theory, Prof. Espy presented to the British Association a paper on "Four Fluctuations of the Barometer." The theory was more fully elaborated in "The Philosophy of Storms," which was published in a large octavo volume by Little, Brown & Co., Boston, in 1841, and was re-enforced by detailed descriptions of a large number of storms occurring on the land and the ocean, the course of which the author had been able to follow and study with considerable accuracy. It also contained his answers to the citicisms which had been made against his theory in the British Association and elsewhere by prominent men of science and rival meteorologists. In it, furthermore, he defended his theory that storms could be produced by large fires making local disturb-

ances in the equilibrium of temperature, whence follow ascending currents, cloud and rain. He spent much effort in trying to secure an experimental demonstration of this scheme, and made unsuccessful petitions to Congress and the Legislature of Pennsylvania for appropriations to enable him to carry them out on an adequate scale. The scheme was not regarded as practicable, and he became the object of some ridicule for his enthusiasm—to which he replied in his book with the self-possession of a man who believes to the full in his purposes: "Gentlemen have made their puns on this project, and had their laugh: and I am sorry to see, by letters which I have received, that my friends and relations at a distance are much troubled by these innocent laughs; but let them be consoled: I have laughed too, well knowing that those who laughed the most heartily would be most willing to encourage the experiment as soon as they discovered they had nothing to laugh at. As a proof that I was right in this anticipation, I may be permitted to say that I have lately received a letter from a highly distinguished member of the American Legislature,* who laughed as heartily as any one when my petition was presented them, containing many kind expressions, and promising me, by way of amends for his levity, to avail himself of the earliest opportunity of being better informed on the subject of my new philosophy. Such conduct as this is all I want; I fear not the strictest scrutiny." The same confident spirit is exhibited in his letter to his superior in the War Department, suggesting a second year of employment in the official study of storms, and which is given in fac-simile on the following page.

In 1843 Prof. Espy was given a position in the War Department, where he could pursue his investigations in atmospheric currents and disturbances, and receive reports from distant points of observation. He instituted a service of daily weather reports, out of which our present Signal-Service system has grown; and, on the basis of this enterprise, as Mrs. Morehead relates in her book, Prof. Henry once remarked to her that there was no question in his mind that "Prof. Espy should be regarded as the father of the present Signal Service of the United States, his 'Theory of Storms' having led the way to its establishment and present success." Prof. Henry added that the charts now used in the service were identical (with some modifications) with those that the "Old Storm King" constructed for use in the Meteorological Bureau of the War Department when he was at its head. A similar acknowledgment was made by General Myer. Prof. Espy was for several years a regent of the Smithsonian Institution, and was brought into close relations and friendship with Prof. Henry. On the occasion of his death, Prof.

* Hon. J. J. Crittenden.

Washington City Sept 10th '45

Dear Sir,

I was placed in your Bureau, at a time when my discoveries in Meteorology were, by a large majority of the people of the United States, supposed to be either humbug, or the vain imaginings of a wild enthusiast.

I have reason however to think that a great change has been wrought in men's minds on this subject since that time. Certain it is, that the great body of facts collated in my First Report to you, is calculated to produce a change, as soon as that Report becomes generally known. It is not for me to say that all the facts yet collected (and you know what a mass we have) go uniformly to prove my theory; but I will say, that the mode of investigating, which I have adopted since I have been in your Bureau, is the only one which will ever demonstrate any theory to be true.

If you agree with me that the subject in which I am engaged is of high interest and utility, you will (as I respectfully ask you to do) make an estimate in your annual Report for the continuance of my labors.

I remain very respectfully yours

Thomas Lawson M.D. James P Espy

Surgeon General U.S.A.

Bache pronounced his eulogy in the Board of Regents, and the Regents passed memorial resolutions, one of which describes him as "one of the most useful and zealous of the meteorologists cooperating with the Institution, whose labors in both the increase and diffusion of knowledge of meteorology have merited the highest honors of science at home, and have added to the reputation of our country abroad."

Prof. Espy delivered many lectures in the towns, cities, and villages of the United States, explaining his theories and the results of his observations. These efforts were very successful, and, according to Prof. Bache, by their originality attracted more attention to his views than could have been obtained in any

other way. "He soon showed remarkable power in explaining his ideas. His simplicity and clearness enabled his hearers to follow him without too great effort, and the earnestness with which he expressed his convictions carried them away in favor of his theory." He was also remarkably successful in gaining the sympathy of public men, and, through them, in obtaining from the Government continued opportunities for study, research, and the comparison of observations. His reports to the Surgeon-General of the Army, to Congress, and to the Secretary of the Navy, are mentioned as among his latest efforts in this direction.

Prof. Espy is charged with the one scientific defect that, with his deep conviction of the truth of his theory, and the enthusiasm it fed in him, he could not pass beyond a certain point in its development, and for the same reasons his deductions were often unsafe. He was not prone to examine and re-examine premises and conclusions, but considered what had once been passed upon by his judgment as finally settled. "Hence his views did not make that impression upon cooler temperaments among men of science to which they were entitled, obtaining more credit among scholars and men of general reading in our country than among scientific men, and making but little progress abroad." But, toward the close of his life, he was induced, by the Secretary of the Smithsonian Institution, to re-examine the various parts of his theories, and to insert in his "Fourth Report," while it was going through the press, an account of his most mature views.

Prof. Espy thought much on subjects of mental and moral philosophy, and after his death his relatives in Cincinnati published his short "Treatise on the Will," which is described as embodying some original and striking ideas.

Personally, according to Prof. Bache, "Prof. Espy was eminently social, full of *bonhomie* and enthusiasm, easily kindling into a glow by social mental action. In the meetings and free discussions of a club formed for promoting research, and especially for scrutinizing the labors of its members, and of which Sears C. Walker, Prof. Henry, Henry D. Rogers, and myself were members, Mr. Espy found the mental stimulus that he needed, and the criticism which he courted, the best aids and checks to his observations, speculations, and experiments. But there was one person who had more influence upon him than all others besides, stimulating him to progress, and urging him forward in each step with a zeal which never flagged—this was his wife." Mrs. Morehead says that "he never seemed impatient or concerned at the slow recognition of his discoveries as means of practical use in commerce or other national needs. He would say, 'I leave all this to the future, sure that its adaptation to the uses of life must one day be seen and acknowledged.'"

CORRESPONDENCE.

SILK-CULTURE IN THE UNITED STATES.

Editor Popular Science Monthly:

Those who have watched with interest the struggle to introduce the culture of silk into the United States, and noted the many failures of those engaged in the work, must feel that, if anything is to be done in silk-culture in this country, new methods must be tried. The old plan of urging women to undertake the work in addition to whatever they may be doing seems in every way impracticable. The "New York Tribune," in July, 1885, in dealing with the subject, says: "It is by no means clear that silk-culture holds out any trustworthy prospect to American women. . . . It has been tried pretty thoroughly in California. At Sacramento and San José cocooneries were established, but, though the experimenters in these places had the advantages of an unequaled climate and Chinese cheap labor, they failed, and failed signally. At intervals similar attempts have been made in other States, but the end has always been the same. . . . The raising of silk-worms involves a minute and incessant labor, such as Orientals appear to be alone thoroughly fitted for, and it is not at all adapted to the capacities of American women."

Despite discouragements and failures the Department of Agriculture at Washington still continues to distribute silk-worm eggs, and in the last annual report for the year 1887 it is suggested by Mr. Philip Walker, the agent in charge, that neighbors might save expense, and realize more for their work, by joining together in the use of one hibernating box, one incubator, and one stifling apparatus. It is thought that the interest has been more active this year in the United States than in the year before, and that progress has been made. The only instance given, however, is that of a woman living in Johnson County, Mo., who, assisted by her mother and four children, tried the experiment for two years, receiving for the cocoons $77.90, which, after deducting her expenses, which amounted to $20, left her $57.90 to show for the labor of six people for two years! Certainly not a very profitable occupation, and, judging by this example alone, not one that would offer special inducements to any one that had the slightest idea of the care and work required to raise even a few ounces of eggs. To be sure, the actual time consumed in the care of the worms could not have been more than six weeks of each year; but would not almost any other occupation have paid better than this?

I am indebted to Mr. Edward Atkinson for the fact that, in the year 1886 alone, the United States imported 16,092,583 dozen eggs, amounting to $2,173,454, and the same year imported 1,937,416 bushels of potatoes, at the cost of $649,009. Now, when it is considered that millions of dollars are expended every year for articles which might as well be raised in this country, does it not seem that it would be better for the Government to help along the industries already started here, and leave silk-culture in the hands of those who have successfully carried on the business for years, and who feel well paid at receiving for their work what to an American would seem only a mere pittance?

Mr. John D. Cutter writes in the "Boston Post" for November 10, 1886, as follows: "As an amusement, silk-culture is all right; as a business, it is impossible, for a generation or two to come, or until we are so crowded in the struggle for life that we can do no better for ourselves than to compete with the Chinese for bare existence. . . . No occupation of any civilized or half-civilized people pays its laborers so little as silk-culture. It is the very last employment of humanity this side of starvation. The reason is patent to any one who will look for it; viz., in this industry the competition is with the Chinese, and the product is of such enormous value in proportion to its bulk and weight that distance is no protection to the producer, because raw silk can be carried around the world for one per cent of its value. . . . Silk-culture is no experiment, even in this country; it simply don't pay a people who want to earn more than one cent per hour."

Light and profitable as the work of raising silk-worms is said to be, there are from the very outset risks connected with it. If the eggs are hatched too early in the season, there is danger of late frosts killing the mulberry-leaves, thereby depriving the worms of their food; the worms are easily affected by changes in the atmosphere, and all through the season there is danger of disease; and provided everything goes well, and one is able to sell the cocoons, the price given for them is small compensation for the time and trouble expended, and if, as is so often the case, the cocoons are pronounced worthless, there is nothing to show for the weeks of incessant labor. Many other experiences might be cited to show the absurdity of encouraging competition with the pauper labor of other countries.

Margarette W. Brooks.

Salem, Mass., *December*, 26, 1888.

THE MENTAL FORCE OF WOMAN.

Editor Popular Science Monthly:

No article, perhaps, that has lately appeared in print has called out a more decided difference of opinion than the one entitled

"The Relation of the Sexes to Government," which appeared in "The Popular Science Monthly" for October. Especially has this been marked in Wyoming, for it is here, I believe, that we find the nearest approach to a relation of both sexes with the Government. In the outset of his article Prof. Cope stated that, "being free from the disabilities imposed by maternity, the male could acquire a greater mastery over his environment than the female." Now, in all observations of animal life lower than man, the contrary appears to be the case. We find the female taking the most active part in the struggle for the existence of the young, and certainly doing as much for her own existence as the male for his. The lioness, in providing for and protecting her young, which in animal life represents the home, exerts a much greater "mastery over the environment" than the male, which only for a brief period shows a care for the female, and neither affection for nor government over the young. The horns of the female kine in defense of the calf are to be dreaded as much as those of the male. We do not find the male cat feeding or protecting the kittens. The hen not only provides for and defends but also chastises and governs her brood. In the insect world we find that the female spider eats her husband, bees kill theirs, and female ants make slaves of theirs. Coming to man, we find that among the Indians the female does the drudgery, and also the providing, with the exception of the hunting. In the wild Kurdish mountains we find women doing labor that the beasts of burden fail in, bringing great bundles of fire-wood down those terrible mountain-sides. We find them protecting their fields from the ravages of bears, fighting and slaying them with as much fury as the men, hindered neither by lack of physical strength nor by maternity. Macaulay speaks of a scene in the Scottish Highlands where aged mothers, pregnant wives, and tender girls are harvesting oats, while the men bask in the sun or angle in the streams.

Prof. Cope claims that women would be irresponsible voters, as they can not assist in the execution of the laws that they help make. Does their physical nature prevent them from doing this? In the riots of Ireland, Canada, and the United States does woman stand back hindered by physical weakness from throwing stones, beating the magistrates, or barricading street-car lines? Can it be proved scientifically that man had rather meet infuriated woman in preference to a male antagonist? In the pioneer days did not woman's bullet speed as true to the mark as man's in the protection of her home? Where has woman failed? In the exhausting marches of exiles to Siberia do the facts show that man stands the journey better than the Russian woman?

Again, the professor says, "The mastery by him has accustomed her to yielding, and to the use of methods of accomplishing her desires other than force." This amounts to saying that, while man is superior in force, woman is superior in diplomacy. Now, if it can be proved that in government the latter is as important as the former, then will be shown the absolute necessity for co-operation of the two sexes in political affairs. In the garden of Eden we find, instead of Adam choking the apple down the throat of Eve, Eve persuading Adam to partake, and here diplomacy wins. It can not be denied by our most adverse opponents that during the last half-century woman has taken possession of educational government. The teachers of the United States to-day are women. Our sex governs the schools throughout this broad land, and we maintain this government, not through force, but through tact or diplomacy.

Here in Wyoming some experience with woman suffrage has been acquired, though in a Territory of course there can not be as wide scope for its exercise as under Statehood. Now, if it could be believed all over this land that women would allow themselves to be "loaded" into wagons by their man, and driven to the polls to vote his ticket, as the writer of the article in question rudely states it, this would give a mighty impetus to woman suffrage. But this is false. Suffrage is not denied woman because she will vote as man dictates, but because she *will not;* and man knows full well that force would very quickly succumb to diplomacy. It is true we go to the polls in carriages placed at our disposal by the candidates, but is this any proof of disloyalty to our convictions? Are the members of a choir who attend the services of the G. A. R. in carriages provided for them to be accused of having no patriotism nor respect for the honored dead? Is it to be supposed that, in spite of birth, education, or culture, we would become as ignorant vassals to the husbands and fathers whose love, respect, and protection we had possessed, or that our male associates are so debased that they would wish us to become such willingly, or compel us to become so unwillingly? There are women, no doubt, who vote as their husbands vote; but, having been a resident and a voter eleven years in Wyoming, I have yet to find one case where a woman has voted as the *force* of man dictated. There are women in Wyoming who do not vote, but it is not because their male associates compel them to remain at home, and they resent such an imputation. Neither is the woman-suffrage movement condemned by them. The majority of the women in Wyoming vote, and vote according to their own preferences, and the men so desire and expect them to vote. It has been stated, rather coarsely, that woman, for the sake of remaining her own master politically, would be tempted to refrain from *legal* marriage. But were this to prove true, and were woman without a legal protector to step up to the

polls to deposit her ballot in opposition to the males, we might look more confidently for exhibitions of force, and, instead of finding woman submitting privately to the maltreatment of her husband, we should see her obliged to suffer publicly the brutality of many men.

I wish that women everywhere would study the one argument that can be brought against woman suffrage. It is this: Woman may reform man. He has shown us clearly that he will not reform himself. Now, unless woman will interest herself in this reformation, she has no business with the ballot. So far woman has done as well as man in the use of the ballot; she has done no better; but she can, if she will. Man has no right to expect woman to take up issues that he ignores, nor has he any right to withhold the suffrage for fear she will do so. But woman in asking for the ballot ought to say to man, We will make better use of it than you have. This is the ground on which we must demand the suffrage. Not the use of the ballot simply to make our own importance greater, but the ballot as it could be used to raise politics out of its filthiness, corruption, and ignorance, and to bring in the reign of purity, patriotism, and intelligence.

THERESE A. JENKINS.

CHEYENNE, W. T., *November* 15, 1888.

EDITOR'S TABLE.

THE DEVIL-THEORY.

IT is a somewhat melancholy thing to reflect that, while we have a ministry of truth in the men who, with dispassionate minds, are applying themselves to discover the laws of nature and the true succession and affiliation of historical phenomena, we have also a ministry of error devoted to opposing, one by one, the conclusions of science, and fostering in the minds of those to whom it is addressed habits of false and inconclusive reasoning. We may quote, as an example of the first, the work of a man like our valued contributor, Dr. Andrew D. White, whose articles on "Demoniacal Possession and Insanity" in recent numbers of this magazine have attracted so much attention. We regret to have to quote as an illustration of the second the recent utterances, on the very same subject, of a man who stands to-day in what but lately was, perhaps, the most progressive pulpit of the whole country, that of Plymouth Church. The Rev. Dr. Lyman Abbott is a man of fine sympathies, of wide culture, and of much moderation of character and judgment. He is a man to whom we should have been disposed to look for steady work in the direction of sound and reasonable views; particularly considering the vantage-ground he occupies as successor to one who, whatever his faults and eccentricities, was ever looking toward the light, and had thoroughly reconciled himself to the leading tenets of modern science. Instead of this, however, we find him accepting to the fullest extent the doctrine of demoniacal possession, and defending it by arguments of the most sophistical character. While the ex-President of Cornell is laboring to banish from men's minds the last vestiges of belief in diabolic agency, the successor of Beecher is handling the devils of ancient narrative with all the tenderness and respect due to the most venerable possessions of the human race. Let us, then, briefly examine what this prominent divine has to say on the topic in question.

Dr. Abbott announces the theory that "evil spirits exercise an influence over mankind." He explains later that by "evil spirits" he means "disembodied spirits"; and adds that there is "nothing unnatural" in their exercising the same kind of control over men that masterful characters exercise over others of weaker will. This hypothesis he holds to be not only scriptural, but more consonant than any other with the facts of science. Charles J. Guiteau, of repulsive memory, he considers to have been a man possessed. "What we call the impulses of our lower nature are often," Dr. Abbott is inclined to think, "the whispered suggestions of fiend-like natures, watching

for our fall and exultant if they can accomplish it." This view invests our life with "a greater seriousness and solemnity than we are wont to imagine" as attaching to it, and makes us realize how important it is "to resist the first yielding to one who never becomes the possessor of a human soul *except by its own gradual and voluntary subjection to his hateful despotism.*"

We have italicized the last few words of the last sentence for an obvious reason. If any "human soul" has "gradually and voluntarily subjected itself" to evil passions, what need is there to call in the hypothesis of diabolic agency to account for even the worst acts of which the man may be guilty? What says an apostle? "Every man is tempted when he is drawn away of his own lust and enticed." The logical law of parsimony forbids us to suppose anything beyond this. What lusts are, we know; what devils are, we know not, nor have we any means even of certifying ourselves in regard to their existence. Why, then, frame hypotheses beyond all need for them? Moral and physical qualities, there is reason to believe, are inherited. Will Dr. Lyman Abbott, standing in Plymouth pulpit, say: "No, it is a family devil that is inherited; the fiend that tormented the father pursues the son and the grandson"? If he will not say that, if he admits that a given individual may receive by inheritance a certain moral and physical constitution, what difficulty is there in believing that to this source may be traced the deeds which mark for good or for evil that individual's life? Dr. Abbott admits that "we can not demonstrate the influence of an invisible spirit over man"; but neither can we, he proceeds to say, "demonstrate the existence of an ether whose waves produce the phenomena of light." The difference between the two cases, however, is very easily stated. The devils are not required to explain any phenomenon; we can get on perfectly well without that hypothesis: whereas, it was necessary to suppose an ether, in order to render the phenomena of light intelligible, by assimilating them to those of sound, produced, as we have discovered, by the vibrations of another medium. We do not doubt, indeed, that the amiable Brooklyn divine would gladly throw the whole doctrine of devils overboard, as not only useless but hurtful, were it not for the sanction which he understands it to receive from the Scriptures. But if it is to be received on faith, why mar the work of faith by trying to show that it may also be accepted on grounds of reason? Faith is only weakened by such help; and reason, certainly, is not benefited by being put to such forced labor.

Take the case of Guiteau. If he had a devil, why did no one of the hundreds of thousands of orthodox believers throughout the country cast that devil out? What do we read? "These signs shall follow them that believe: in my name shall they cast out devils." Did any one so much as try to cast the devil out of Guiteau? The only utterance we distinctly remember as proceeding from the pulpit at the time was a passionate demand by the eloquent preacher of the Brooklyn Tabernacle for the hanging of Guiteau on a gallows as high as Haman's. If Guiteau really had a devil, it was certainly hard on him that the faith of the Christian world was at so low an ebb that no one cared even to try to relieve him of it. Who knows what an innocent and amiable person he might have become if the uncanny tenant could only have been dislodged? The American nation, however, adopted no such theory. Devil or no devil, they held Guiteau responsible for his crime, and hanged him accordingly.

Dr. Abbott talks of the "gradual and voluntary subjection" of a human soul to the "hateful despotism" of a disembodied fiend. But how does this agree with the New Testament narratives? Are the persons who are there mentioned as having been freed from

diabolic possession represented as having deliberately and voluntarily given themselves into the power of the fiends? By no means. They are represented rather as the helpless victims of the Evil One; and when the devils have left them, they are in as sound a moral condition (for aught that is hinted to the contrary) as if they had never been possessed. They are not told to go and sin no more, as was the woman taken in adultery. They are not warned, as Dr. Abbott warns his readers, against putting themselves, of their own free will, in the power of the fiend. Had their subjection to evil been gradual and voluntary, how could their corrupted and debased moral natures have been transformed in a moment by a word addressed not to them, but to the indwelling devils? The fact that on one occasion the devils were gratified by being allowed to enter into a herd of swine would seem to show that personal merit or demerit had nothing to do with their choice of an abode. It is not to be supposed that those particular swine were sinners above all the swine that dwelt on the shores of Gennesaret. If Dr. Abbott will therefore consider the matter candidly, he will see that his theory has the double fault of scandalizing reason and opposing Scripture. Surely it is time that, for men as intelligent and with as liberal instincts as Dr. Abbott, the bands of authority were broken in matters of this kind. What do we want with devils in nineteenth-century thought? Can any honest man say that we need them as a working hypothesis for scientific purposes? Would not such a hypothesis rather prove an obstacle to scientific investigation by drawing attention away from the natural antecedents of crime and insanity? What misery has been wrought by this doctrine in past ages Dr. White has well shown. To-day it is a mere wretched survival from ages of ignorance, and one which a wise man, if he can not afford openly to combat, should at least studiously and conscientiously ignore.

LEARNING TO THINK.

In every-day life no fact is more noticeable than the inability of many persons to do their own thinking, even in matters and upon lines wholly within the range of their intelligence. They will see a point that is suggested to them, and will at once understand its bearing on some matter in hand; but they do not seem to have the faculty or art of raising points for themselves, and consequently their action is not as intelligent as it might be. If given a rule to work by, they will apply it, not only in season but out of season, and will look amazed if one suggests that, under special circumstances, they should have varied their usual procedure. Every employer and overseer of labor knows to what an extent this is the case. It is the exceptional workman who really thinks, and who can therefore be trusted to suit his action to circumstances. And so in nearly every sphere of life; a kind of automatism seems to be the rule, and intelligent self-direction, in the light of present facts, more or less the exception.

One is, therefore, tempted to ask whether, in connection with our systems of education, some gymnastic might not be devised for the special purpose of teaching the rising generation to think. The mere introduction of the natural sciences into school and college courses will not suffice; for, as was shown in a report published in these columns a few years ago, the sciences may be taught with very little intellectual result. What is needed is to form the habit of thought *in connection with everything;* and, without assuming to speak with authority, we can not help inclining to the opinion that this might be done by presenting every object of thought as something not complete in itself, but as requiring, for its proper comprehension, to be considered in its relations to other things. Nearly every act of stupidity committed in daily life arises from disregarding the

relations of things—in other words, treating something or other as if it stood apart, in no kind of dependence on anything else. How many such acts would be avoided by the simple reflection that such and such a thing must have had a cause, or that it is sure to have a consequence! How many, by no more profound or acute exercise of thought than is involved in recognizing that a thing can not both be and not be at the same time! How many, by some simple consideration of time, place, or quantity! How many, by a mere question as to the meaning of a word!

One of the main points in education, therefore, ought to be, as it seems to us, to form the habit of treating everything as the possible subject of a great number of questions, some of which at least must be asked and answered before the thing can be, in any true sense, understood. Habit is everything, and if the habit of asking questions, arranged under certain categories, could once be formed, the victory of intelligence over mental inertia would be secured. It is probable that not a little harm is done in the education of the young by unduly appealing to the sense of wonder. Wonder is essentially a stupid emotion; it certainly is the one that stupid people are most eager to gratify. The object of wonder stands alone, challenging attention as being something out of the ordinary course of things. But just in proportion as wonder is excited is rational inquiry discouraged. People do not want to have the marvelous so explained as to bring it into the category of natural and necessary phenomena. From the days of Anaxagoras, who got into trouble for propounding a physical theory of the sun, down to our own time, men have resented explanations of what they have chosen to consider beyond or above explanation. In lieu of wonder, however, we may very usefully stimulate curiosity; and this may be done in a general way by representing everything as leading us on, if properly considered, to views and truths beyond itself—as having its own "aura," as the physicists sometimes say, of force or influence, and certain related objects with which it maintains constant communication.

The successful teacher will be he who, whatever his subject may be, knows best how to present things in their relations; who deals not with unconnected units, but with the vitally connected parts of some organic system of knowledge; and who himself is penetrated by a sense of the interdependence of the truths or propositions that form the matter of his teaching. It ought to be possible to make all instruction subserve the purpose of stimulating thought, of giving to every mind a free activity of its own. The thinking that is required for an intelligent direction of the ordinary concerns of life is not abstruse thinking; it is, on the contrary, in nine cases out of ten, if not in a much larger proportion still, essentially commonplace thinking. We hear from time to time much foolish disparagement of theory as opposed to practice; but there is just this much foundation for the popular prejudice on the subject, that brilliant theoricians are occasionally apt to overlook the simpler and more ordinary aspects of the matters with which they deal; while plain, plodding men, if intent on business, will at least guard the points that most commonly present themselves, and will thus, in the majority of cases, bring things to a successful issue. Educational effort should be most distinctly bent upon giving every human being the habit of asking questions as a preparation for action. The questions need not in most cases be asked of others: it is often enough to raise and distinctly face them; then the answer comes of itself. We have had too many examinations in which the mind is put to a strain, and too little work of the kind involving no strain, but simply tending to keep the mind in a healthy condition of activity

and alertness. At home as well as at school, children should be taught to think the thoughts that are suited to their age and capacity; and the neglect of such thought as is quite within their powers should be treated as a fault. We are confident that when a general effort comes to be made for the specific purpose of awakening intelligence, and when, for the furtherance of this end, we throw away a great quantity of the useless lumber with which we now encumber the minds of the young, the result will be a great development of good sense and practical efficiency.

LITERARY NOTICES.

A TEXT-BOOK OF GENERAL ASTRONOMY FOR COLLEGES AND SCIENTIFIC SCHOOLS. By CHARLES A. YOUNG, Ph. D., LL. D. Boston: Ginn & Co., 1888. Pp. 550. Price, $2.40.

PROF. C. A. YOUNG'S "Text-Book of General Astronomy for Colleges and Scientific Schools" is a work worthy of the reputation of its author, and creditable to the progress of American science. Not only his long experience as a teacher is manifested in the book, but also the character of his teaching, which is clearly that of a man in close sympathy with his students, who perceives accurately the attitude of their minds toward the subject, and knows just when and where to lend assistance. It is no mere compilation, but, to an uncommon extent, an original work. In some text-books of astronomy many things that the really earnest student wants to know seem to have been carefully excluded; he gets results, but not the methods of attaining them, and he can not help feeling that the author has kept him out of the secret, as if it were a performance in prestidigitation. Prof. Young's book is admirably free from this fault. He not only explains principles and methods with unusual distinctness, but he is careful to show the student where to go for further or fuller information. And when he sends the beginner to higher works he starts him off with a clear conception of what he is to go for, which in itself is half the battle. Moreover, he takes pains to point out the limitations of the science—a thing of greater importance than may at first sight appear. For instance, what he says of the nature of the attraction of gravitation is something that the ordinary student rarely gets, but that is of the first importance for a proper comprehension of the subject: "We must not imagine the word 'attract' to mean too much. It merely states the fact that there is a *tendency* for the bodies to move toward each other, without including or implying any explanation of the fact. So far no explanation has appeared which is less difficult to comprehend than the fact itself. Whether bodies are *drawn* together by some outside action, or *pushed* together, or whether they themselves can act across space with mathematical intelligence—in what way it is that 'attraction' comes about is still unknown—apparently as inscrutable as the very nature and constitution of an atom of matter itself; *it is simply a fundamental fact*" (p. 109).

The whole tone of the book is stimulating and suggestive. It is interesting to the general reader as well as to the student. The chapter on "The Earth as an Astronomical Body," for instance, is a beautiful example of comprehensive treatment combined with clear and succinct statement, including, with an explanation of just those principles that the student needs to have made plain, a summary of the latest knowledge which interests everybody. To particularize a little, we have not seen in any work of the kind so perspicuous and satisfactory an account of the Foucault experiments with the pendulum and the gyroscope as that given by Prof. Young.

Among the little things, which are too often entirely overlooked by writers of text-books, but whose suggestiveness and value in awakening the interest of the student, and clarifying his ideas, have been recognized in this book, we note the demonstration of the eastward deviation of falling bodies (p. 94); the explanation of how the height of the mountains of the moon is measured (p. 170); the ingenious proof of the moon's rotation (p. 154); and the stimulating little example on page 123, showing how the eccentricity of the earth's orbit may be found from the greatest and least apparent diameters of the sun.

As was to be expected from the author's wide reputation and recognized authority as

an observer of solar phenomena, the chapters on the sun are among the most interesting, instructive, and generally valuable portions of the book. It is worth while to quote two or three passages from these chapters in which he sums up the latest results of investigation and theory. After quoting Secchi's later eruption theory of sun-spots, and pointing out an obvious objection to it, he remarks: "Perhaps the true explanation may be that when an eruption occurs at any spot the *photosphere somewhere in the neighborhood settles down in consequence of the diminution of the pressure beneath*, thus forming a '*sink*,' so to speak, which is of course covered by a greater depth of cooler vapors above, and so looks dark" (p. 190).

In regard to the disputed question of the influence of solar disturbances, as indicated by sun-spots, upon the meteorology of the earth, concerning which some extravagant notions have recently been set forth, Prof. Young says, "It is now quite certain that whatever influence the sun-spots exert upon terrestrial meteorology is very slight, if it exists at all." This statement, coming from one who ranks so high as an authority on solar physics, must be rather discouraging to those who have been trying to fix the responsibility for every great tornado, or other unusually destructive storm of late years, upon some unfortunate sun-spot.

Our author speaks with characteristic modesty, and yet very interestingly, of the phenomenon of "the reversing layer," first observed by him during the solar eclipse of 1870, and which seems to indicate the existence of a gaseous stratum or shell surrounding the photosphere, and not above five hundred miles in thickness, to which the formation of the dark lines in the solar spectrum is mainly due. While by no means abandoning his own opinion of the probable nature of this phenomenon, he frankly states the opposing view of Mr. Lockyer, and points out how observation may be directed to settle the question.

A most inspiring and encouraging statement for those who may be troubled by doubts as to whether any important discoveries remain to be achieved by future students of the sun is that "among the many thousand lines of the solar spectrum only a few hundred are so far identified." There are twelve elements familiar to us on the earth, which are known to exist in the sun, and nine others of whose existence there the evidence is not quite conclusive. Prof. Young does not pronounce quite so positively as some foreign *savants* have done against the validity of Dr. Henry Draper's conclusion that his photographs had demonstrated the presence of oxygen in the sun, but he remarks that the latest work appears to turn the balance of evidence the other way. He still accepts Rosetti's determination of the effective temperature of the sun, 18,000° Fahr., as being the most probable that has yet been obtained.

The extraordinary mental picture that we must form of the solar globe, as a body in the gaseous condition and yet possessing in its nuclear mass a consistency like that of tar, has become familiar to readers of the literature of science since the publication of Prof. Young's admirable book on "The Sun." In the present work he presents in briefer form the same general conclusions concerning the constitution of the sun. There are few who will be disposed to accept by preference the views of those who hold that the great mass of the sun is probably liquid instead of gaseous. The brief synopses given of our knowledge of the nature of the visible phenomena of the sun are exceedingly clear and succinct. To begin with the photosphere, which, as the reader knows, is the visible surface of the sun, from which the splendor of its light arises: "The photosphere is probably a shell of *incandescent clouds*, formed by the condensation of the vapors which are exposed to the cold of space.

"The photospheric clouds float in an atmosphere containing, still uncondensed, a considerable quantity *of the same vapors out of which they themselves have been formed*, just as in our own atmosphere the air around a cloud is still saturated with water vapor. . . .

"The chromosphere and prominences are composed of the *permanent gases*, mainly hydrogen and helium. . . . The appearances are for the most part as if the chromosphere was formed of jets of heated hydrogen ascending through the interspaces between the photospheric clouds, like flames playing over a coal-fire.

"The corona also rests on the photosphere, . . . but extends to a far greater ele-

vation than even the prominences ever reach, and seems to be not wholly gaseous, but to contain, besides the hydrogen and the mysterious 'coronium,' dust and fog of some sort, perhaps meteoric."

While the part of the book devoted to the sun is so excellent, it must not be supposed that the other divisions of the subject have not received adequate attention. In fact, one of the strong points of the work is that it is well balanced, and the student gets as complete a view of the science as is possible within the limited space of a school text-book. The author, in setting forth with uncommon clearness the elementary mathematics of his subject, has not ignored what may be called its philosophical aspects. He has, for example, given an account of the nebular hypothesis which, notwithstanding its brevity, can not fail to be of much use in dissipating the fog that hangs over this whole subject in the minds of those who have little knowledge of astronomy beyond what has been vouchsafed to them in the ordinary college curriculum. We should have been pleased to see from Prof. Young's pen an elementary account of George Darwin's remarkable theory of "tidal evolution," in place of the references that are given to other popular explanations of that subject.

Recent discoveries have carried us so far into the depths of space that there is nothing within the circuit of astronomical knowledge and investigation which appeals more strongly to inquiring minds than the relations of the solar system to the universe without. Such achievements in observation as those of the Lick telescope, and the recent surprising advances in astronomical photography, promise us much light upon the old problem of the structure of the heavens. Prof. Young's remarks in the present work on the distribution and motions of the stars, though brief, are fruitful in suggestion. We quote the following passage as a particularly interesting generalization: "In the solar system the central power is supreme, and perturbations or deviations from the path which the central power prescribes are small and transient. In the stellar system, on the other hand, the central force, if it exists at all (as an attraction toward the center of gravity of the whole mass of stars), is trifling. Perturbation prevails over regularity, and '*individualism*' is the method of the greater system of the stars, as solar despotism is that of the smaller system of the planets."

This remark, which is fully justified by all we now know of stellar motion, presents a very different picture of the universe from that which has sometimes been drawn for the edification of admiring congregations, of planets circling around suns, and suns around other suns, and these systems around grander systems still, and finally the whole universe revolving with a stupendous orbital sweep around the great center of all, the throne of the Creator himself! It appears that things don't revolve that way.

There are many good features in the book that we should like to point out if space permitted. It may be remarked, by the way, that a fine example of the author's desire to convey practically useful information is the italicized sentence on page 35: "*Never turn the hands of a chronometer backward.*"

It goes without saying that the more mathematical parts of Prof. Young's work are highly excellent, succinct, and clear. Such subjects as central forces, the tides, parallax, the equation of time, and perturbations are treated in such a way as to give the student a sure insight into the nature of the problems involved.

The illustrations accompanying the text are good, many being original, and some excellent ones borrowed from the author's book on "The Sun" (published by Appletons), and from other sources. Some useful tables of elements and constants, based upon the most recent information, close a book which, it is not too much to say, will be scarcely less welcome to the general reader than to the students for whose instruction it is intended.

FORCE AND ENERGY: A THEORY OF DYNAMICS. By GRANT ALLEN. London and New York: Longmans, Green & Co. Pp. 161. Price, $2.25.

MR. ALLEN'S theory does not aim to revolutionize the generally accepted ideas concerning force, but is rather an attempt to classify the known forms of force, and systematize their relations. Under the general term power he includes forces and energies, distinguishing them by their effects. Thus,

he defines a force as a power which tends to bring together portions of matter (and possibly of ether), while an energy has the opposite effect. He divides forces into four species: gravitation, which aggregates masses of matter; cohesion, which aggregates molecules; chemical affinity, which aggregates atoms; and "electrical affinity," which aggregates "electrical units." An instance of the operation of this last force is the discharge of a Leyden jar, by which positive and negative electricities are brought together. "In our present ignorance of the subject," he says, "electrical affinity must be placed in the same category as other forces; though further researches will doubtless enable us to give a better account of its real nature." Of the unit on which this force acts, the "electrical unit," he says that its nature "is very inadequately known to us," but that it "must be considered for our present purpose as in some way the analogue of the others, though we have no sufficient warrant for giving it any material properties." For further particulars he refers to a chapter on "Electrical Phenomena," but diligent search fails to discover such a chapter in the book. The author divides energies on the same principle as forces. "But owing," he says, "to the existence of two modes of energy, the potential and the kinetic, it will not be possible to assign a single definite name to each species." An instance of the action of a "molar energy" is afforded when we lift a weight from the ground. Heat, which separates molecules, is a "molecular energy." As an instance of a "chemical energy" employed in separation, he gives the power which effects the electrolysis of water. Hence, if we understand Mr. Allen rightly, the action of a current of electricity in electrolysis is the action of two powers of opposite kinds. For his aggregative power, or force, "electrical affinity" must be acting between the poles of the battery immersed in the water, while his separative chemical power, energy, is tearing apart the atoms of hydrogen and oxygen. He mentions light and intense heat as other examples of chemical energy. His instance of (separative) "electrical energy" is the friction which produces a disunion of the positive and negative electrical units in the electrical machine. But he adds that "as in the case of electrical forces, our treatment of this department must be considered purely temporary and symbolical." There are two modes of energy, the potential and the kinetic, and each of the four species of energy may exist in either mode. Motion has three kinds: separative, aggregative, and continuous or neutral. Each species of kinetic energy has a form of each kind. The principle commonly called the conservation of energy Mr. Allen names "the indestructibility of power," applying the former term in accordance with his use of the word energy, while he uses "the persistence of force" to denote the indestructibility of "aggregative power." In stating these principles the author gives us another distinction between force and energy, the former being inherent in the particles of matter, never passing from one unit to another, while energy may be transferred from one particle or set of particles to another. Not only do energies oppose forces, but one force may "interfere" with another: thus, when a weight is suspended by a cord, the cohesion of the cord counteracts the force of gravitation. So also energies may be "suppressed" by forces or by other energies. "Liberating energies" are those which release bodies from the control of one force and bring them under that of another.

With two short chapters on the nature of energy and the nature of motion the author closes the "abstract or analytic" part of his book. In the "concrete or synthetic" part, which follows, he describes the operations of force and energy in the evolution of the sidereal system, the solar system, the earth, and organic life, closing with a general view of the energies which the earth possesses. In an "apology" prefixed to the volume the author states that he has kept his theory in manuscript for a number of years, and explains why it is now published. "It pretends to be," he says, "no more than a suggestion, an *aperçu*, an attempt at a theory: I ask for it nothing better than honest consideration."

HUME'S TREATISE OF HUMAN NATURE. Edited by L. A. SELBY-BIGGE, M. A., Fellow and Lecturer of University College. Macmillan & Co., Clarendon Press. 1 vol., pp. 709. Price, $2.25.

THIS celebrated treatise is now reproduced in admirable style, containing, in addition to the text, the original title-pages of

1739 and 1740; the original advertisements, and a critical index by the editor; the latter intended, in the language of the preface, to "point, not loudly but unmistakably, to any contradictions or inconsequences and . . . to any omissions of importance." This valuable index occupies thirty pages of fine print. Altogether, the present edition is a credit to all who have been concerned in its preparation; and no inconsiderable service is done to philosophy by thus calling attention again to the great importance of Hume in the development of philosophical thought.

The "Treatise of Human Nature" was finished by Hume when he was scarcely twenty-five years old; and its final composition occurred in the village of La Flèche, in France, where his philosophical predecessor, Descartes, was educated. The result of its publication, in England, was, to use the author's own language, that "it fell dead-born from the press, without reaching such distinction as even to excite a murmur among the zealots." It was not till his "Essays, Moral and Political," were published (1741–1748), and achieved notable success, that any measure of attention was bestowed upon the "Treatise"; and indeed the significance of the latter in the history of philosophy was not made manifest till the world became acquainted with Kant's "Critique of Pure Reason," which was first published at Riga in 1781.

This relation between Hume and Kant can be studied to advantage in the Introductions to Hume's works by the late Prof. T. H. Green, of Oxford, who was the leader of the Hegelian *coterie* of that institution. These Introductions are now accessible in a separate volume (Longmans, Green & Co., 1885). If Green's statements were limited to the English experiential school, before the doctrine of evolution appeared as a factor in philosophical thought, they would not stand in so much need of correction. As they are, however, they do need correction; but, nevertheless, they exhibit tolerably well the true position of Hume as the precursor of Kant. The former marked the close of an epoch, that of the course of thinking of which Locke was the progenitor. To Kant's mind Hume demonstrated the necessity of a new point of departure and a new method. This invests the "Treatise of Human Nature," his most important work, with a peculiar interest. To use Green's language, but with a less wide application of the terms "old" and "new"; the "Treatise" and Kant's "Critique" "taken together, form the real bridge between the old world of philosophy and the new. They are the essential 'propædeutik,' without which no one is a qualified student of modern philosophy."

The reader who desires to learn something more about Hume will do well to peruse the little volume entitled "Hume," of the Blackwood series of "Philosophical Classics for English Readers," written by William Knight, LL. D., Professor in St. Andrews University. This book gives both a good biography of Hume and an outline of his philosophy, a great deal in small compass; though, as in the case of Green's works, the reader of Knight's volume must be on his guard against a strong bias adverse to Hume's philosophy, and indeed to that of the English experiential school generally.

DOWN THE GREAT RIVER: EMBRACING AN ACCOUNT OF THE DISCOVERY OF THE TRUE SOURCE OF THE MISSISSIPPI, etc. By Captain WILLARD GLAZIER. Philadelphia: Hubbard Brothers. Pp. 443+liii. Price, $2.

IN this book Captain Glazier relates the story in full of his journey, in 1881, by the aid of an Indian guide, "across country," from Brainard, Minnesota, to "Glazier Lake," south of Itasca Lake, and his determination of it as the real source of the Mississippi River. The journey was made first to Leech Lake, which is on one of the main affluents of the upper Mississippi, and is the seat of an Indian agency, and thence up a chain of lakes and portages, through a territory of which very little if anything was definitely known, to Itasca Lake; around Itasca Lake to the largest stream flowing into it; up that stream to "Glazier Lake," and around that lake till the author was satisfied that nothing important was likely to be found above it. Thence Captain Glazier descended in canoes, through all the windings and the lakes of the main stream of the Mississippi, and down the river to its mouth; the whole of this journey being performed in one hundred and seventeen days. He claims that his is the only party that has thus

explored the whole length of the river. As determined by the author, "Glazier Lake" is in about latitude 47°; is 1,585 feet above the level of the sea, and is 3,184 miles from the Gulf of Mexico. The river reaches its highest northing at Lake Bemidji, in the neighborhood of latitude 47° 30'. Captain Glazier's claims to be the discoverer of the true source of the Mississippi have been disputed by some persons, who have affirmed that the lake which has been named after him was not unknown to Schoolcraft, and that it has been visited by hunters. The author replies to these objectors by affirming that, no matter how many persons may have known of the existence of that body of water, he was the first to explore it, to gauge its dimensions, and to determine that it is the ultimate source of the Mississippi; and he cites a large number of declarations of geographers and of men versed in the history, geography, and traditions of Minnesota which support his claims in this shape. He represents "Glazier Lake," though its superficial area is less, as being deeper and containing more water than Itasca Lake. The story of the explorer's journey is very pleasantly narrated, with descriptions of the notable points along the river and the more striking scenes, and is embodied in a neat volume which is adorned with appropriate illustrations.

LECTURES ON PEDAGOGY: THEORETICAL AND PRACTICAL. By GABRIEL COMPAYRÉ. Translated, with an Introduction, Notes, and an Appendix, by W. H. PAYNE, A. M. Boston: D. C. Heath & Co. Pp. 491.

ALTHOUGH deeming that the best system of teaching "which we make for ourselves through study, experience, and personal reflection," M. Compayré says also that "in order to aid the reflection and guide the experience of each novice in instruction, the book is very far from being useless though it do nothing more than stimulate personal reflection. It is just in this spirit, less for imposing doctrines than for suggesting reflections, that this modest volume has been written." He divides the treatise into two distinct parts, theoretical pedagogy and practical pedagogy. In the first part, after a general consideration of the function and limits of education, the author states the general principles of both physical education and intellectual education, and then takes up the special culture of the various faculties, beginning with the education of the senses. Besides treating of the essential faculties which are constantly being employed in mental operations, he makes a plea for the culture of the imagination, justifying this tribute to its importance by a quotation from Mr. Blackie, who says: "It is the enemy of science only when it acts without reason—that is, arbitrarily and whimsically; with reason it is often the best and the most indispensable of allies." The education of the feelings is also urged in a chapter which leads up to the subject of moral education. Æsthetic and religious training are likewise included in the scope of education. Under practical pedagogy, methods of teaching and rules of school management are treated. In regard to the importance of method he says: "There is nothing to be expected from a discipline which is hesitating and groping; from instruction which remains incoherent and disorderly, which fluctuates at the mercy of circumstances and occasions, and which, being wholly unpremeditated, allows itself to be taken at unawares." The principal methods of teaching to read are first described, some advice on the teaching of writing is given, and the simultaneous teaching of reading and writing is touched upon. The author has a chapter on object-lessons, pointing out their true character, and telling how they have been distorted by some teachers. In dealing with the study of the mother-tongue he points out some general principles, and tells the special use of grammar, dictation exercises, analysis, composition, elocution, and literary exercises in teaching knowledge of language. The teaching of history and of geography are treated in like manner. His chapter on the sciences is devoted mainly to arithmetic and geometry, while the physical and natural sciences are disposed of in three pages. He seems inclined to rate the acquirement of facts as a more important purpose of science-teaching than the formation of the habit of observation; therein, as in what few other suggestions he gives on this subject, following the French official programme of instruction. Methods of moral and civic instruction, and the teaching of drawing and music, are treated in some detail. Manual labor for

boys, agriculture, and military drill, manual labor for girls, sewing, and domestic economy, are touched upon. The two closing chapters deal with rewards and punishments, and discipline in general. The text is divided into paragraphs, each with a title. Throughout the volume the author makes evident his belief that a living, active personality is needed in addition to rules and formulas, in order to make any system of education effective.

CIVILIZATION AND PROGRESS. By JOHN BEATTIE CROZIER. London and New York: Longmans & Co. 1888. Pp. 477. Price, $1.50.

IN this work there is much to commend. The defect seems to be a failure to properly condense and clarify the thought. Again, there is, perhaps, too much reference to particular men as exponents of intellectual movements. Not that names should be neglected, but more prominence is given to the person than to the thought represented; leading to the false impression that men make an epoch instead of the truth that the epoch makes men, who are only representatives of the intellectual feeling of their times. But, apart from these matters of minor criticism, the book is a most excellent one, for the reason that the author aims to show, and succeeds in showing, the controlling factor in any social progress "to be the material and social conditions, and not, as so many believe, moral exhortation and appeal." This rests on the law that "in this world things make their own relations—that is to say, their own morality—in spite of politicians or priests. Now, should this turn out to be a true law, it will not only settle speculatively the basis on which civilization rests, but will also furnish a practical guide for action. Its importance, therefore, can not be overestimated. For if the moral relationships of the great masses of men—their ideals, opinions, and habits of thought—grow directly out of their conditions of life, it is evident that, instead of sitting invoking (*sic*) a lofty morality which will prove as obstinate as the fire invoked by the priests of Baal, it behooves us rather to set to work resolutely to bring about that amelioration in the material and social conditions without which the higher morality can not arise." This is a truly scientific position to assume, and the fact that the author takes it entitles his work to the consideration of disciples of science. As to the value of the idea set forth, there is much force in the author's contention that we ought to regard with serious attention the question whether we can have any such thing as equality or security in rights unless there be substantially a social equality of power. If power be unbalanced, the stronger will oppress the weaker, and endeavor to perpetuate its domination at the expense of the latter. This process will go on till the pressure of the more powerful becomes unbearable, and provokes violent and destructive eruptions leading to all sorts of convulsions. Hence we must not expect any stable social equilibrium unless there be an equality of power—that is to say, of material and social conditions.

Accessory to this central thought of Mr. Crozier's work are many interesting criticisms, historical, political, religious, and ethical. The book is worthy of careful study, and is a genuine contribution to sociologic science.

In his *Complete Graded Course in English Grammar and Composition* (D. Appleton & Co.), Mr. Benjamin C. Conklin has endeavored to compass with a single volume the entire range of the usual *two-book* course. This he does by making it sufficiently elementary in the beginning to be put into the hands of pupils in the lowest grammar grades, and sufficiently advanced to cover all that is required of the highest grammar classes. The theory of the book is the gradual development of the sentence; the method inductive. The teachings of the text are exemplified by graded sentences, which in themselves afford a concrete presentation of the whole subject; and these are accompanied by questions so framed as to require the pupil, after a study of the text, to formulate his own answers. Analysis and synthesis are so carried along together as to develop, with the knowledge of the structure of the sentence, the power to use language. Instead of giving examples of false syntax for correction, a better way is sought of accomplishing the same object by presenting exercises for filling out sentences by supplying the correct forms of words in blank

spaces. But examples of false syntax are given in an appendix, for teachers who prefer them.

In the *High-School German Grammar* of *W. H. Van der Smissen* and *W. H. Fraser* (D. Appleton & Co.), while the lessons and exercises have been made progressive as far as possible, each separate subject is fully treated before being dismissed. Care has been taken that no grammatical point shall occur in any sentence on which the pupil has not been previously instructed, and that the principles of past lessons as well as of the current lesson shall appear in every exercise. Supplementary lessons, designed mainly for reference, are devoted to special cases of grammatical usage. Those points in which German differs from English usage, particularly with regard to the prepositions and their puzzling idioms, the use of participles and the construction of participial clauses, and the order of words and construction of sentences, are explained. The vocabulary gives such meanings of words as occur in the exercises; and the index is full.

American educators now have offered to them the *Systems of Education* of Prof. *John Gill* (Heath, $1.10). The work is a history and criticism of the educational principles, methods, organization, and discipline which have been in use in England, and consists of lectures which it became the author's duty to prepare, as Professor of Education in the Normal College, Cheltenham. The first man whose ideas produced an important effect on English education was Roger Ascham, and his "Scholemaster," though dealing primarily with classical teaching, yet contains principles which are applicable to all school subjects. Comenius, Milton, Locke, and Vicesimus Knox are the other educationists whose teachings have been influential in shaping the grammar schools of England. The Edgeworths and Pestalozzi are credited with most strongly modifying the development of the common school. Oberlin, Wilderspin, the Mayos, and Froebel are the most prominent names in the history of infants' schools. In the conduct of the elementary school, designed for pupils whose education will not proceed far, Dr. Andrew Bell, the founder of the monitorial system, has the earliest place. Joseph Lancaster, a contemporary of Bell, employed substantially the same methods. Without displacing the monitorial organization, there grew up after a time what was called the intellectual system, which made the culture of the intelligence its special aim. A further advance in the same direction was made by David Stow, who devised the training system, which is here presented with especial fullness. The book closes with a chapter on amateurs and helpers, who, though not professional teachers, have had more or less influence in developing systems of education.

In the *Report of the Commissioner of Education for* 1886–'87 (Government Printing-Office), the commissioner, Hon. *N. H. R. Dawson*, states that the bureau has undertaken to investigate the history of American education, beginning with the sections of the country whose educational history is comparatively unknown. Monographs on William and Mary College and the University of Virginia, with sketches of other Virginian colleges, have been prepared. The commissioner devotes considerable space to telling the condition and needs of education in Alaska, where he has personally made a tour of inspection. Since his appointment, he has simplified the organization of the bureau, and has succeeded in hastening the publication of the annual reports. The volume contains the usual information about the schools of the country, and an index to the publications of the bureau, from 1868 to 1887, with a list of the same.

The second of the "Contributions to American Educational History," now being published by the Bureau of Education, is on *Thomas Jefferson and the University of Virginia*, by Prof. *Herbert B. Adams*, and contains also authorized sketches of Hampden Sidney, Randolph, Macon, Emory, Henry, Roanoke, and Richmond Colleges, Washington and Lee University, and Virginia Military Institute. Jefferson's efforts in the cause of education, and the history of the establishment of the University of Virginia, are given with much fullness. An interesting chapter in the account tells how the example of this university over sixty years ago aided the birth of what is now called "the Harvard idea." The record is made more valuable by numerous illustrations, part of them, including a portrait of Jefferson, being borrowed from a recent article on Jefferson in

"The Century." Views of the buildings of the other colleges described are also given. Several special articles on the university are contributed by various writers, viz.: "Influence of the University upon Southern Life and Thought," and "The Writings of the Faculty of the University, 1825–'27," by William P. Trent, A. M.; "Present Organization and Condition of the University," by Prof. John B. Minor; "The Elective System of the University," by Prof. J. M. Garnett; and a "Bibliography of the History of the University," by the editor.

The book on *Manual Training in Elementary Schools for Boys*, by *A. Sluys* (Industrial Education Association, New York, Part I, 20 cents), will form Nos. 7 and 8 in the series of monographs published by this association. The author is principal of the Normal School of Brussels, and has studied the subject of manual training in Sweden, whither he was sent for this purpose by the Belgian Minister of Education. His book has been translated for this series, with the belief that it is the best and most accurate as well as the most condensed treatment of the subject that has yet appeared in any language. In the first part of this work, now before us, the author states the two standpoints from which manual training is advocated, the economic and the pedagogic, giving a somewhat detailed view of the economic side of the subject. An account of the schools of Nääs, and a history of instruction in manual training in the primary schools of Sweden, are the other topics treated in this portion of the book. There are some traces of the translation process in the English of this pamphlet. We note, for instance, the expression "whets the saw," and on the same page the visitors are made to say, "We have often assisted the pupils in their manual work at the Nääs school," where the original phrase undoubtedly meant "to be present at"; and in the Gallicism "assisted at," at the foot of the next page, the translator has reproduced the form of the same phrase instead of its meaning.

In his oration on *The American University*, delivered at Columbia College, June 2, 1887, Prof. *Charles Sprague Smith* expresses the view that the future university of this country must be formed in harmony with the development of the American people; that the last two years of the usual college course may be taken as the first two of the university, relegating the present freshman and sophomore work to a preparatory course; that election of courses rather than of separate studies should be allowed in the university, and but little or no election in the academies; and that the scope of the university should be twofold—to instruct the few and to enlighten the many.

Prof. *Robert T. Hill* delivered before the University of Texas, October 26, 1888, an inaugural dissertation on *Some Recent Aspects of Scientific Education*, in which he points out that the introduction of the study of the natural sciences into the modern system of education has had a vast and beneficent influence on the popular mode of thought, and of searching for truth, on the public health, on the art of agriculture and the mechanical arts, on our knowledge of man, on the methods of education itself, and on the progress of sociology. He touches also upon the benefits of the extension of university study into the homes of the people.

According to Secretary *S. P. Langley's Report*, the Smithsonian Institution is overtaking the capacity of the fund to sustain it, and is beginning to need larger resources. New accommodations are needed for the National Museum; the library, now including 250,000 volumes, and extremely valuable, is so crowded in the Congressional Library rooms as to be of little use; the erection of an astro-physical observatory is suggested. The first part of Prof. Cope's work on the reptiles and batrachians of North America is in the hands of the printer. Explorations are mentioned in Japan, the islands of the Gulf of St. Lawrence (for remains of the great auk), Central America, and Alaska. A steady falling off is remarked in the rate of addition to the quarto series of Smithsonian "Contributions," while the series of "Miscellaneous Collections" grows much more rapidly. The recent accessions to the museum (12,000 groups or lots of specimens since the present building was opened) include several extensive collections. The increasing popularity of this department is proved by the increase of 32,463 in one year in the number of visitors (249,025 in 1887–'88). A higher standard than the average is

claimed for the clerical force of the Institution, and its excellence is attributed to the absence of politics.

The sixth and seventh parts of Mr. *Richard A. Proctor's Old and New Astronomy* (Longmans, Green & Co., London and New York) relate to the physical functions and constitution of the sun and to the planet Mercury. The author's method of treatment is clear and interesting; he is well at home in the subject, and has endeavored to serve it in this book as one should serve the chosen and ultimate work of his life. The publishers have done their part in making the work attractive, presenting a page of pleasant aspect, abundantly illustrated with figures intended to make the text more easily intelligible, and engraved in a style that leaves nothing to be desired.

Several monographs have been sent us by Dr. *Alexis A. Julien*—reprints of papers read during several years past before scientific societies. The one among them of the most direct value is that on the *Decay of the Building-Stones of New York City*, in which the various stones employed in architecture and their several qualities—particularly those affecting their durability—are described. In the *Genesis of the Crystalline Iron Ores*, the various theories on the subject and the author's conclusions are given.—*The Sealed Flasks of Crystal* calls attention to the liquid inclosures in crystals, which are more frequent than they are known to be, explains their occurrence, and tells how to find them.—A double paper *On the Variation of Decomposition in the Iron Pyrites; its Cause, and its Relation to Density*, besides the features of treatment suggested, tells many things concerning a common mineral, in a style acceptable to the general reader.—Other papers in the list are *On the Geology of Great Barrington, Mass.; Notes on the Glaciation of the Shawangunk Mountain, N. Y.; The Dunite Beds of North Carolina;* and the *Volcanic Tuffs of Challis, Idaho, and other Western Localities.*

According to the *Report of the State Mineralogist, W. J. Irelan, Jr.*, the State Mining Bureau of California is satisfying a want which the State has been in much need of since the beginning of quartz or ledge mining. It is gathering the records of the earliest mining ventures, collecting statistics of present developments, studying the methods of recovery of the precious metals, examining the unexplored mineral sections, determining the lithological structure of the inclosing rocks, and making known to the world the mineral resources of the State. It has collected an extensive museum of specimens, and is accumulating a valuable library of books treating on the subjects for which it was created. The report for 1888 treats all of the counties of the State separately, with all matters bearing upon their mining interests and development; and its nine hundred and forty-nine pages are full of information respecting the geology, mineralogy, mines, method of working, machinery, and results of each district.

The Reports and Bulletins of the Agricultural Experiment Stations, whether examined collectively or separately, furnish information of value, to a large extent fresh. One from *Hatch Experiment Station of the Massachusetts Agricultural College* (No. 3, January, 1889) is devoted chiefly to *Tuberculosis.*—The *Annual Report* of the *Connecticut Station* for 1888 includes a paper on *Fertilizers*, their analysis and value; *Bulletin* No. 96 of the same station (January, 1889) is on the *Valuation of Feeding-Stuffs.*—*Bulletin* No. 2 (October, 1888) of the *Storrs School Station*, Mansfield, Conn., records *Experiments on the Effects of Tillage upon Soil Moisture.*—*Bulletin* No. 4, of the *New York Station*, Geneva, is on the *Chemical Composition of some Feeding-Stuffs* (grasses, clovers, forage-crops, grains, and by-products).—*Bulletins* Nos. 3 and 4 of *Cornell University Station* (November and December, 1888) relate to certain insects and to the growing of corn for fodder and ensilage.—*Bulletin* No. 3 of the *University of Illinois Station* (November, 1888) relates to *Field Experiments in Oats.*—*Bulletins* Nos. 2 and 3 of *Iowa Agricultural College Station* contain thirteen articles on "Corn-Tassels, Silks, and Blades"; "Characteristics of Hardy and Tender Fruit-Trees"; "Promising New Fruits, Grasses, Insects, and Insect Remedies," and other subjects.

The Report of the Commissioner of Internal Revenue, Hon. Joseph S. Miller, for the last fiscal year, deals chiefly with tobacco, spirits, substitutes for butter, and adultera-

tions. A large increase is shown in manufactures of tobacco and collections therefrom, while the manufacture of spirits decreased during the year by 7,552,193 gallons, the decrease being wholly in whiskies and high-wines. A large and valuable portion of the report deals with butter substitutes, and the laws and regulations of different countries respecting them and adulterations. The commissioner also publishes, as a separate document, the *Regulations for the Analysis of Foods and Drugs in the District of Columbia;* to which is appended a list of substances that are dangerous or that are harmless when present in foods. Bibliographies accompany both pamphlets.

With the new year several new periodicals have come into being and invite attention. The *Cumberland Presbyterian Review* is a quarterly publication, devoted to theology and the discussion of current religious, literary, and scientific topics, and questions connected with church work and moral reform. It is edited by J. M. Howard, D. D., and published at Nashville, Tenn., by the Board of Publication of the Cumberland Presbyterian Church. Among the articles we note those of President A. B. Miller, on the "Physical Basis of Moral Reform"; Prof. Hinds, on "Charles Darwin"; Prof. Tigert, on "Our Senses, how we use them, and what they tell us"; and T. M. Hurst, on the "Decay of Christian Citizenship," as probably most likely to interest our readers. *The Collegian* is a monthly, devoted to the interests of undergraduates, edited by *Samuel Abbott*, and published at Boston under the auspices of the *Intercollegiate Press Association*. It aims to be the central organ of our four hundred and fifty or more colleges, with their more than one hundred and eight thousand students; and is to be, except for the "special paper," the work of undergraduates. The paper, "A Worker in Stone," in the first number, is a truly scientific study of Indian relics. Another paper claiming attention is a symposium, or collection of letters on "The Influence of Athletics upon the Curriculum." *Germania* is a fortnightly journal for the study of the German language and literature, edited and published by A. W. Spanhoofd, at Manchester, N. H. It will attempt to teach the language and to acquaint its readers with the best of German literature by publishing graded reading exercises and selections from the representative authors. *The Educator*, *W. H. Smith*, editor, Buffalo, monthly, September to June, will undertake to give to persons in schools knowledge of what is going on in the world; of affairs of the State and nation, scientific adventures and discoveries, and the good in literature. Pp. 16, $1 a year. *Electric Power*, *R. W. Pope* and *G. H. Stockbridge*, editors (Electric Power Publishing Company, New York), is devoted to the interests of the electric railway, and of the transmission of power by electricity for industrial purposes. Monthly. Pp. 24, $3 a year. *The Business Woman's Journal*, *Mary F. Seymour*, editor and publisher, New York, is a monthly devoted to the interests of all women, especially of those engaged in active pursuits. It believes that women may succeed in every sphere of life, and will advocate the recognition of their right to have their success acknowledged; "will be the organ of no special reform, but of all," and "will look at the woman's side of every question." Pp. 24, $1 a year.

President G. Stanley Hall's American Journal of Psychology, now in its second volume, well carries out the high purpose with which it started. In the latest number, Prof. Sanford gives a study of the "Personal Equation," including the history of the observations and the results of the investigations that have been made on the subject; Dr. W. H. Burnham considers the "Memory" from the historical and experimental points of view; and Mrs. Putnam-Jacobi discusses "The Place for the Study of Language in a Curriculum of Education." In the notices in "Psychological Literature," which include many titles, works and papers on the nervous system are reviewed by Prof. Donaldson, and those in the experimental field by Prof. Jastrow. $5 a year.

The *Harvard Law Review*, monthly, is published by students of the Harvard Law School, with George R. Nutter as chief of the editorial board. The numbers for October and November, 1888, contain an essay by Mr. Samuel Williston on the "History of the Law of Business Corporations before 1800," which received the prize offered by the Harvard Law School Association—a prize which has the promise of becoming an an-

nual one, at least for several years to come. A summary of the "Liquor Statutes of the United States" is given by William Church Osborn in the October number. The general list of contributors includes several publicists of national fame; 35 cents a number, $3.50 a year.

The *Manufacturer and Builder*, *W. H. Wahl*, editor (Henri Gerard, publisher, New York), now in its twenty-first year, is devoted largely to the building trades, and whatever relates to them, and well occupies its field, which it makes to cover a wide range of subjects. The number for January, 1889, shows continued improvement. Among other matters it has a review of progress during 1888. $1.50 a year.

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POPULAR MISCELLANY.

Natural Purification of Polluted Streams.—The growing population of the many cities which discharge their sewage into rivers gives increasing importance to the question how great a degree of pollution is allowable in a stream of given flow, the water of which is to be used lower down for domestic or for manufacturing purposes. Mr. Rudolph Hering says that oxidation and decomposition of sewage matter was for a long time thought to be the main cause for the clarification of polluted rivers. To-day it is known to be but a minor cause compared with dilution and subsidence; and if the sewage is discharged in a fresh condition into a stream of water, its destruction is in part due to fish and other aquatic animals. Some of the refuse from stock-yards is disposed of, no doubt, in this way. Most of the decomposition, or oxidation as it is usually termed, of sewage is effected by the myriads of microscopic plants, microbes, or bacteria contained in both air and water, which at once seize upon the dead organic matter. For purifying the sewage discharged into a river, oxidation can be depended upon only to a limited extent, because of the comparative slowness with which it takes place. Subsidence of the heavier matter tends to clarify it before it flows many miles; dilution with a sufficient quantity of clean water prevents an offensiveness almost at once; but oxidation requires many days under continuous aëration of the river. From a comparison of data in regard to the actual purification of polluted streams we may draw the following inference: Rivers not to be used for water-supplies, but to be inoffensive to communities residing a few miles below, to remain fit for ordinary manufacturing purposes, and to sustain the life of fish, may receive the sewage from one thousand persons for at least every one hundred and fifty to two hundred cubic feet of minimum flow per minute, supposing that natural subsidence of the heavier matter takes place immediately below the town discharging the sewage. Beyond the above limit it appears to be advisable to resort to land or other filtration, or to chemical precipitation. But the whole subject needs further investigation.

The Nebraska City Pontoon Bridge.—Colonel S. N. Stewart, of Philadelphia, has recently built a pontoon bridge for ordinary traffic across the Missouri River, at Nebraska City. It is 1,074 feet long, 24½ feet wide, and consists of a flooring laid upon boats which float upon the river and are securely anchored. The city has held a franchise for such a bridge for twelve years, but the project has been opposed by persons interested in steamboats plying on the river. Many predicted that the attempt would fail, for the Missouri River has a swift current, which here attains about its highest velocity, and large numbers of logs and trees are constantly drifting in the stream. These, however, are carried under the floats without doing any damage. In the channel of the river the bridge makes a V, pointing down stream, which is the draw. To open the draw, the connections at the point of the V are cast

off, and the current swings the two sections apart, leaving a free opening 528 feet wide. It is the widest draw in any bridge ever built. The ends of the section are connected by a sunken steel-wire cable, and the draw is closed by winding this up on a capstan, worked by one man. There is a pontoon bridge across the Mississippi River at Prairie du Chien, the draw of which requires a powerful engine to close it. The bridge is to be removed each winter when ice covers the river. Both the pontoon bridge and a crib-work structure 1,050 feet long which crosses a second arm of the river were built in twenty-eight days, at a cost of about $18,000. For the spring floods it is proposed to greatly increase the strength of the steel anchoring cables. The bows of the boats are to be sheathed with iron, and the bottoms are to receive an extra planking of oak. A railroad bridge of steel crosses the river near the pontoon bridge. This was built between December, 1887, and June, 1888. Heretofore pontoon bridges have been little used except as a temporary expedient for military purposes; but their cheapness, and the satisfactory character of the draw and other details in the form just described, bespeak for them a more extended use.

Somali Traits.—The Somalis, as represented by Mr. F. L. James, who has traveled among them, are a curious people, hostile to Europeans, treacherous, "marauding, semi-civilized half-castes, offshoots of the great Galla race, allied to the Caucasian type by a steady influx of pure Asiatic blood. They are Mohammedans, but the rites of their religion sit loosely upon them. Although their trust is in Allah, they have been known to ask where he can be found, as some of them would like to catch him and spear him for having laid waste their homes and killed their wives and cattle. Yet they let off sudden prayers with great fervor during moments of anxiety." The hire of camels and drivers to the traveler was ratified by an oath that, if the man failed to keep the terms of the contract, he would divorce his wife. Mr. James had to engage women-servants, because the men refused to build their own mat-huts or do any cooking. None of their fathers had done this, they argued, and were they to do the work of women the tribes through which they passed would despise them. At one place the people believed the caravan had descended from the heavens, and this was confirmed when Mr. James and the others began to smoke. "The pipe was part of ourselves, for how else could our mouths blow forth clouds, which would of course bring down rain?" The author explained that these clouds were not "water-bearers," but were due to plants lighted by harmless fire-makers," and to prove this one of the party struck a match and lit a fresh cigarette. This caused further bewilderment. The match had produced lightning, and of course the cloud could produce thunder; so the travelers were "storm-makers."

Healing of the Broken Bones of Birds.—It is not often that doctors are able to observe a broken bone almost in the very act of healthful healing, as has recently been the privilege of Dr. R. W. Shufeldt. He obtained on the same day a red-tailed hawk and a turkey-vulture which had been shot while high in the air with a 0·45 caliber government carbine; the ball in the former case passing clear through the chest, and in the latter case breaking in two the radius and the ulna. The hawk's wound could not be discovered, and the bird was apparently whole and vigorous. When killed and dissected, three weeks afterward, it was found that all of the costal ribs and the scapula had been broken across, but were now substantially healed. The ribs had individually made a good union and there was no anchylosis among them, and the blade of the scapula, though not perfect, was in essentially as good a condition as ever; the whole constituting a case of "a fearful wound with a truly magnificent recovery." The buzzard, besides having been shot, had been kicked about by the soldiers, "and was more dead than alive." It had recovered, and could fly well in about a week, when it was killed. The union of the bones was complete and firm, and a mass of callus was being rapidly absorbed at the sides of the fracture, while the bones had remained practically straight. From this and other cases within his experience, the author is convinced that, in case of fractures of the bones of the wings in birds, the good unions that result with

hardly any deformity or shortening are largely due to the material assistance afforded by the quills of the primary and secondary feathers, which act as splints. Were this not the case, and if deformity ensued, the bird would be crippled in its power of flight, or deprived of it.

Food and Economical Plants of Abyssinia.—The most important of the food-plants of Abyssinia is the *taff* (*Poa Abyssinica*), a cereal bearing grains as small as a pin's head, from which the general bread is made. An inferior black bread is made from a kind of millet that grows in low grounds. Roasted flax-seed is sometimes eaten. The flower-stock of the plantain, cooked with milk and butter, is very tender, has the flavor of new bread somewhat underdone, and is an excellent dish. From the leaves of the *ensete* mats are made. The *ecca*, an asclepiad, furnishes a tough fiber, which is used in making cordage and twines. Other fibers, for various uses, are furnished by the bark of the *Calotropis gigantea;* and the tender leaves newly pulled from the stipe of the doum-palm are wound into all kinds of matting and basket-ware. The powdered seed of a large tree called *herebera* (*Milettia ferruginea*) is thrown into the water to stupefy fish, and makes it more easy to catch them. The chief articles of export are calves' hides, salted and dried, beeswax, ivory, tamarinds, ostrich-feathers, gutta-percha, gum arabic, mother-of-pearl, leopard-skins, musk, honey, and tobacco.

Interest in Reading.—The primary object of ordinary reading or study, Mr. Balfour holds, in his rectorial address at St. Andrews, is the enjoyment to be obtained by the possession and acquirement of knowledge. Knowledge is most easily attained in those subjects which we like most and take most interest in; and by that principle we should be directed to the kind of reading which we should take up. By the same principle we should not try to read the books on the list of the hundred or so best, merely because they are on the list; but when our interest is fixed on a particular line, the list is good to refer to for the best books bearing upon it. What interests the ordinary man at one time does not interest him at another; but "his interests change with the changes that are going on around him in the world. He sees some natural curiosity, reads something in the newspapers, hears of some incident or character in history, or goes to some place which awakens his interest and attention, and induces him to read. If the ordinary man, then, is to read what interests him, he is pretty sure to read widely, and therefore necessarily, since life is short, superficially. . . . Now, can it be said, that the man who reads like this, with freshness and vigor, eager to find out something, to get light on a subject dark to him before, will not get more knowledge, and so benefit himself vastly more, than the man who, with slow and painful steps, heavily plods through a list of books, though that list has on it all the masterpieces of creation?"

House-top Summer-Resorts.—A plan to make our house-tops useful is sketched by Dr. Gouverneur M. Smith, in a paper on "Wasted Sunbeams—Unused House-tops." The Oriental has no difficulty in the matter; he lives on the top of his house a considerable part of the year, and builds his roof with an especial eye to that sort of occupation. Why may not we? By pitching our tents upon them, or by taking them as they are, except that the roof-coverings would have to be made more solid, we might make our roofs comfortable sojourning-places and inexpensive summer health-resorts. "Roofing," says the author, "can be contrived suited to this climate, and enduring as pavement. A pleasure resort might ornament each residence, its limits bounded by the area of the dwelling; neighborly consent could widen the range, turf and flowers brightening the plan. Iron-framed and glass-inclosed rooms or cupolas could be added, which would prove useful during all seasons, artificial heat tempering brumal inclemency. If such adaptation of house-tops would be an advantage to the affluent, who can escape city life during the summer, how much greater advantage would be secured to the tenement-house districts! . . . For the higher graded tenement-houses, such fresh-air facilities would be hailed with delight by the inmates. The proximity of open breathing-places totheir rooms would endear their humble homes. Summer moonlight even-

ings could have a new aspect; and again, round a family lantern, groups might gather to read, sew, or engage in games, and thus a home-felt pleasure could quiet restless spirits, craving questionable or illicit amusements. More true enjoyment might be observed in such groups than on the piazzas of fashionable resorts. Landlords could arrange for the periodical sweeping of roofs, as well as of the halls and stairways, and, among a very large class of the respectable poor, pride would stimulate to a tidy and decorative care of their home parks." By a little alteration in structure the upper stories of houses, now stuffy places enough, could be made light and airy, and attractive as resorts or play-rooms in inclement weather. This recalls the papers contributed by Mr. Bunce in "Appletons' Journal" several years ago, in which a similar utilization of the roofs of the tall houses just then coming into fashion, or their conversion into gardens, was advised and illustrated with pleasing descriptions of what might be.

Adolf Sutro's Water-Power.—Mr. Adolf Sutro's aquarium at San Francisco, though at a higher level than the ocean, is fed by sea-water in sufficient quantities to furnish a strong constant stream by the action of natural forces only. How it is done has been told, in the California Academy of Natural Sciences, by Mr. Theodore H. Hittell, who indicates also what may be a new economical power. The aquarium is on the lee side of a jutting rock. Through this rock, and leading out to its exposed face, is a short tunnel, while on the face of the rock most exposed to the rollers of the ocean is an excavated hollow place or basin, the bottom of which is several feet above high-water mark. As the rollers come in they dash violently against the face of the rock, rise in mingled water and foam to a very considerable height, and splash over into the basin. The water thus caught in the basin does not fall back into the ocean, but runs through the tunnel into the aquarium and maintains its high level. Between that level and the level of the ocean in the cove, where there is no rock to dash against and no splashing, there is a fall, as indicated by the running stream, of several feet—enough to furnish very valuable water-power. The principle of gaining a head of water thus applied may obviously be made of great importance at many points along the coast. Though the main body of water to be caught is thrown up only during high tide, there is hardly any limit to the amount that may be thus secured, provided the basin is large enough and not too elevated.

Fast Railway-Trains.—Some remarkably fast time has been made recently by trains between London and Edinburgh, in consequence of a rivalry between the Northwestern and the Great Northern Railways. The journey formerly took nine hours, but last summer the former road reduced the time to eight hours and a half. Its rival then made it eight hours, and, on August 6th, the Scotch Express, on the Northwestern, covered the distance in eight minutes less. The times of the runs made without stopping on this trip were: Euston to Crewe (158 miles), 2 h. 56 m.; Crewe to Preston (52½ miles), 51 m.; Preston to Carlisle (90 miles), 1 h. 38 m.; Carlisle to Edinburgh (100¼ miles), 1 h. 45 m.; the average speeds attained being the highest yet reached. On the second day of the accelerated service, this train, consisting of an engine with six coaches, made the run from Crewe to Preston in fifty minutes, and that from Preston to Carlisle in ninety minutes. This is claimed as beating every previous record.

Sagacity of the Blood-hound.—The blood-hound is declared by Dr. Gordon Staples, from his own somewhat wide experience, to be one of the most sagacious of all dogs. "His wisdom when quite a puppy is sometimes astonishing. When only six months old, he will often show to his master that he has already come to the conclusion that life is real and earnest, and not meant merely to romp and play in. I have had a puppy at this age take me quite in charge, as it were, giving himself all the airs and manners of a dog of seven years old, and going on watch at nightfall as serious as a sentry in an enemy's country. He would look up in my face as much as to say: 'There's nobody in this wicked world worth a thought except you and me, master, and you don't count as far as defense goes; if you please, I'll do the watching for both.' As a rule, the blood-

hound is most docile and willingly affectionate. He can be trusted with children; so much so, that a boy may safely do duty as the 'hunted man' when the hound is being trained in hill or forest. The animal is nevertheless suspicious of the motions of strangers; he therefore makes a most efficient guard either to person or to property." Both scent and sight are remarkably well developed in the blood-hound; the animal is beautifully formed all over for hard work, but does not excel in speed. In olden times he was called the "slow-hound," among other names, and when the trail was perceptible, even to human senses, the dog was taken on horseback to save time. Great value is put upon the hound's up-bringing and general treatment when not on duty. "If the creature has been reared and trained by a fool, and under the influence of fear—if he be not well kept, properly bedded, exercised, and fed, and allowed the companionship of man, he is certain to develop more or less of nervous debility, and ten to one will go wrong at the critical moment. . . . Some people doubt the possibility of dogs tracking a criminal through the streets and lanes and busy thoroughfares of a crowded city. They speak of cross-scents; but in doing so they speak of what they do not understand as well as—the blood-hound does. He has got the right scent at the right place, and, if he is the right sort of dog, he will stick to that and no other. Besides, it has been done over and over again."

Diet and Disease.—Dr. A. Hunter's new cook-book—"Culina Famulatrix Medicinæ; or, Receipts in Modern Cookery, with a Medical Commentary"—contains much plain speaking with reference to certain dishes which are supposed to contribute to the increase of the business of doctors. A certain giblet-soup is described as containing "a considerable amount of gout and scurvy." A mock-turtle soup is pronounced "a dangerous dish, and will soon bring a man to his crutches"; a second kind is denounced as "a most diabolical dish, only fit for the Sunday dinner of a rustic who is to work the six following days in a ditch-bottom"; and of a third, the author observes, "there is death in the pot." Other dishes of equally elaborate composition, and to the lay view as indigestible, are well spoken of; whence it may be inferred that the author is as prejudiced as scientific.

NOTES.

Dr. H. A. Hare, of the University of Pennsylvania, has issued, through P. Blakiston, Son & Co., Philadelphia, his essay on "Mediastinal Disease," to which the Medical Society of London awarded the Fothergillian medal for 1888.

A curious story of foster relationship between a wood-duck and a hen is told by a Mr. Palmer. The duck was hatched along with a brood of chicks from an egg that had been placed under the hen. It was attended as well as her other chicks by the mother, and reached adult age. Then, when the hen brought out another brood of chicks, it kept in close attendance, much to the hen's annoyance, and with occasional resultant fights. Finally, the duck drove away the hen and took exclusive care of the chicks during the day, only giving them up at night.

A new oil-burning light, called from its inventor the Doty light, is said to be well suited for lighting all places where brilliant illumination, without dark shadows, is required at moderate cost and without elaborate preparation. In it oil is forced by compressed air through a tube which has been formed into a double coil. The coil is heated, so that the oil is vaporized in passing through it, and, becoming ignited at the burner, issues in a brilliant flame. The pressure of the air is kept up by a few occasional strokes upon a hand-pump. Three sizes of the light are placed upon the market—300, 500, and 1,000 candle-power. The inventor claims for it numerous advantages resulting from its being self-contained, self-generating, and portable.

The greater prevalence of diphtheria, small-pox, and scarlet fever in the cold seasons of the year is explained by Dr. H. B. Baker as resulting from the tendency in those periods to catarrhal inflammations of the respiratory tract. This is also exemplified in the prevalence of influenza, bronchitis, and tonsillitis. The cause of these forms of inflammation may be found in the retention of non-volatile salts in the mucous lining of the air-passages.

The land of the salt-district in Cheshire, England, is gradually undergoing subsidence in consequence of the pumping up of the brine which is produced by the solution of the rock-salt far below the surface. As this brine is removed, fresh water takes its place, and this reacts upon the rocks, forming new brine, which is pumped up in its turn. And so the process goes on year after year, with constant removal of the props of the earth.

EXPERIMENTS have been made by Mr. Saunders, of the Experimental Farms, Ottawa, in the cultivation of grains from the extreme north of Europe, for the purpose of securing varieties that will ripen in the shortest Canadian summers. Wheat from Lake Ladoga, latitude 69°, ripened from ten to fifteen days earlier than other varieties in cultivation; a difference sufficient to insure its maturing soon enough to escape the earliest autumn frosts. This wheat yielded nineteen-fold, and was of satisfactory quality. Onega wheat, from latitude 62°; barley, from latitude 66°; and barley and rye from latitude 67°—or from the extreme northern limits at which cereals are grown in Europe in a continental climate—are on trial.

How dependent schools were, and to some extent still are, on books as contrasted with individual power, is illustrated in the life of the late Prof. Thomas Hill Green. The first time he competed for the Queen's medal at Rugby he complained that, though the judges liked his essay the best, they gave the prize to another boy, "because his essay showed more labor, i. e., came out of thirteen books instead of his own head." In the next competition he was successful, contrary to his own expectation, for the subject was one for which, he says, he had "to consult a variety of forty authorities, which I never can succeed in doing well; I always find that, if I cram myself with the ideas of others, my own all vanish."

A NEW life-saving jacket—Mr. J. Johnson's "Eclipse Life-Belt"—consists of twenty corrugated metal tubes joined with durable webbing, so adjusted as to give the tubes a vertical position on the chest and back. It has a supporting power of thirty-two pounds in fresh water. The belt can be readily adapted to the side of a ship's boat to render it unsinkable.

A SUFFERER from sleeplessness avers that he has found a remedy for his trouble by holding his breath till discomfort is felt, and repeating the process a second and a third time. The "Lancet," while it admits that this method may produce the desired effect, mentions some dangers connected with it which would make its general adoption unadvisable. Another victim of insomnia, regarding the affliction as a consequence of mental worry and deficiency of exercise and fresh air, advises hygienic living, moderation in eating and drinking, and abstinence from stimulants. In dealing with severe nervous irritation from mental or physical work, he has found a daily rest an almost essential prelude to sleep at night. This advice is pronounced sensible.

M. DES CLOIZEAUX has become President of the French Academy of Sciences; and M. Hermite has been chosen Vice-President, to become President in turn in 1890.

THE Medico-Chirurgical Society of the Canton of Berne, Switzerland, has offered prizes for the best and next best essays on the question, "Up to what point is there ground for entertaining the criticisms which have been made from a medical point of view on the intellectual overpressure of children in the schools of a Swiss territory?" Essays of a purely theoretical character, and compilations from books embodying facts which the competitor has had no means of personally examining, will not be considered. The essays may be in French or German.

MR. IM THURM noticed, in the course of his explorations in British Guiana, that tamed animals of many species—parrots, macaws, trumpeters, monkeys, toucans, etc.—were kept in some of the Indian villages. They take the place of currency. These Indians, not having yet risen to the civilization of a protective system, carry on special occupations in their different villages: thus in one they spin, in another make mats, in a third pottery, in a fourth cassava-mills, etc. Some of the trading is done by barter between the villages, and the balances are adjusted with this living "currency."

THE seventieth birthday of Prof. Von Pettenkofer—the father of hygienic science, as the Germans call him—was celebrated in Munich on the 3d of December, with enthusiastic demonstrations by the students, and visits and testimonials from scientific and medical men of all parts of Germany. Among those who thus honored him were the civic dignitaries of Munich; the National Liberal party; representatives of the royal family; numerous scientific and medical societies and universities at home and abroad; the Prussian Minister of Education; and old pupils. The students had a grand torchlight procession on the evening of the 5th, which was addressed by Pettenkofer, and ended with a shout and a song.

A COMPENDIUM of transoceanic weather observations—from Walfisch Bay, South Africa; Hatzfeldhafen, New Guinea; and the coast of Labrador—has been published by the "Deutsche Seewarte." The last observations were made by missionaries on the initiative of the "Seewarte." Such observations will hereafter be regularly published in yearly volumes.

AMONG the more important papers in the "Year-Book" of the Italian Meteorological Society for 1887 are those of Ferrari on the relations of sun-spots to earth-magnetism, of Pagliani on the relations of cholera and weather, and of Roster on those of the air and health. The "Year-Book" also contains a bibliography of all Italian works on meteorology that appeared in 1886.

AN Anthropological Congress is to be held in Vienna in August.

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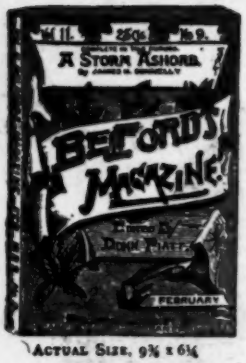

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VOL. XXXIV.] ESTABLISHED BY EDWARD L. YOUMANS. [NO. 2.

THE POPULAR SCIENCE MONTHLY.

DECEMBER, 1888.

EDITED BY W. J. YOUMANS.

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GENERAL LIBRARY UNIVERSITY OF MICHIGAN

FORTY-THIRD ANNUAL REPORT OF THE

NEW YORK LIFE INSURANCE CO.

Office: Nos. 346 & 348 BROADWAY, NEW YORK.

JANUARY 1, 1888.

Amount of Net Assets, January 1, 1887.....$71,819,623.48

REVENUE ACCOUNT.

Premiums	$19,823,519.87		
Less deferred premiums, January 1, 1887	1,041,666.15—	$18,286,853.72	
Interest and rents, etc.	4,252,480.50		
Less interest accrued, January 1, 1887	486,497.10—	3,765,983.40—	$22,052,787.12
			$93,872,410.60

DISBURSEMENT ACCOUNT.

Losses by Death, and Endowments matured and discounted (including reversionary additions to same)	$4,961,366.83	
Dividends (including mortuary dividends), annuities, and purchased insurances	5,173,843.96	
Total paid policy-holders	$9,568,210.79	
Taxes and re-insurances	264,495.60	
Commissions (including advanced and commuted commissions), brokerages, agency expenses, physicians' fees, etc.	3,581,026.06	
Office and law expenses, salaries, advertising, printing, etc.	629,360.98—	$13,960,093.43
		$79,912,317.17

ASSETS.

Cash on deposit, on hand, and in transit	$3,068,499.60	
United States Bonds and other bonds and stocks (market value, $52,255,514.82)	49,068,266.14	
Real Estate	6,867,092.59	
Bonds and Mortgages, first lien on real estate (buildings thereon insured for $14,000,000 and the policies assigned to the Company as additional collateral security)	15,960,373.78	
Temporary Loans (market value of securities held as collateral, $2,404,858)	1,867,500.00	
* Loans on existing policies (the Reserve on these policies, included in Liabilities, amounts to over $2,000,000)	888,799.44	
* Quarterly and semi-annual premiums on existing policies, due subsequent to January 1, 1888	1,174,340.36	
* Premiums on existing policies in course of transmission and collection. (The Reserve on these policies, included in Liabilities, is estimated at $1,800,000)	839,156.02	
Agents' balances	170,792.59	
Accrued Interest on investments, January 1, 1888	488,477.59	$79,912,317.17
Market value of securities over cost value on Company's books		3,167,528.68

* A detailed schedule of these items will accompany the usual annual report filed with the Insurance Department of the State of New York.

TOTAL ASSETS, January 1, 1888.....$83,079,845.85

APPROPRIATED AS FOLLOWS:

Approved losses in course of payment		$937,078.86
Reported losses awaiting proof, etc.		292,214.54
Matured endowments, due and unpaid (claims not presented)		27,582.20
Annuities due and unpaid (claims not presented)		13,042.96
Reserved for re-insurance on existing policies; participating insurance at 4 per cent Carlisle net premium; non-participating at 5 per cent Carlisle net premium	$68,807,642.00	
Additional amount of Reserve (transferred from Surplus account) required on account of new State Standard of valuation (Actuaries' 4 per cent), taking effect December 31, 1887	1,592,098.00—	70,399,740.00
Reserved for contingent liabilities to Tontine Dividend Fund, January 1, 1887, over and above a 4 per cent Reserve on existing policies of that class	4,176,425.25	
Addition to the Fund during 1887	1,785,602.54	
	$5,962,027.79	
DEDUCT— Returned to Tontine policy-holders during the year on matured Tontines	646,306.96	
Balance of Tontine Fund, January 1, 1888		5,315,720.83
Reserved for premiums paid in advance		52,886.75
		$76,428,265.74
Divisible Surplus (Company's new Standard)		6,651,580.11
		$83,079,845.85

Surplus by the present New York State Standard, i. e., 4 per cent Actuaries' (including the Tontine Fund).....$11,846,793.06

From the undivided surplus, as above, the Board of Trustees has declared a Reversionary dividend to participating policies in proportion to their contribution to surplus, available on settlement of next annual premium.

Number of Policies issued during the year, 28,522. Risks assumed, $106,749,295.

Total number of Policies in force December 31, 1887, 113,323. Amount at risk, $358,935,536.

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Premiums		$19,228,519.87	
Less deferred premiums, January 1, 1887		1,041,666.15—	$18,286,853.72
Interest and rents, etc.		4,252,480.50	
Less interest accrued, January 1, 1887		496,497.10—	3,755,983.40—$22,052,787.12
			$93,872,410.60

DISBURSEMENT ACCOUNT.

Losses by Death, and Endowments matured and discounted including reversionary additions to same)	$4,261,363.83	
Dividends (including mortuary dividends), annuities, and purchased insurances...	5,178,843.96	
Total paid policy-holders	$9,585,210.79	
Taxes and re-insurances	284,685.60	
Commissions (including advanced and commuted commissions), brokerages, agency expenses, physicians' fees, etc.	3,561,024.06	
Office and law expenses, salaries, advertising, printing, etc	629,860.96—$13,960,996 48	
		$79,912,317.17

ASSETS.

Cash on deposit, on hand, and in transit	$3,038,499.60	
United States Bonds and other bonds and stocks (market value, $52,255,814.82)...	49,088,256.14	
Real Estate	6,867,092.50	
Bonds and Mortgages, first lien on real estate (buildings thereon insured for $16,000,000 and the policies assigned to the Company as additional collateral security)	15,969,372.78	
Temporary Loans (market value of securities held as collateral, $2,404,858)	1,807,500.00	
* Loans on existing policies (the Reserve on these policies, included in Liabilities, amounts to over $2,000,000)	288,789.44	
* Quarterly and semi-annual premiums on existing policies, due subsequent to January 1, 1888	1,174,340.26	
* Premiums on existing policies in course of transmission and collection. (The Reserve on these policies, included in Liabilities, is estimated at $1,300,000)	889,158.06	
Agents' balances	170,792.59	
Accrued Interest on investments, January 1, 1888	666,477.50—$79,912,317.17	
Market value of securities over cost value on Company's books		3,167,528.68

* A detailed schedule of these items will accompany the usual annual report filed with the Insurance Department of the State of New York.

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APPROPRIATED AS FOLLOWS:

Approved losses in course of payment	$337,078.83	
Reported losses awaiting proof, etc.	292,214.54	
Matured endowments, due and unpaid (claims not presented)	27,582.20	
Annuities due and unpaid (claims not presented)	14,842.26	
Reserved for re-insurance on existing policies; participating insurance at 4 per cent Carlisle net premium; non-participating at 5 per cent Carlisle net premium	$68,807,612.00	
Additional amount of Reserve (transferred from Surplus account) required on account of new State Standard of valuation (Actuaries' 4 per cent), taking effect December 31, 1887	1,302,006.00—	70,396,740.00
Reserved for contingent liabilities to Tontine Dividend Fund, January 1, 1887, over and above a 4 per cent Reserve on existing policies of that class	4,176,423.25	
Addition to the Fund during 1887	1,165,672.54	
DEDUCT—	$5,342,027.79	
Returned to Tontine policy-holders during the year on matured Tontines	646,806.96	
Balance of Tontine Fund, January 1, 1888		5,315,720.83
Reserved for premiums paid in advance		52,886.73
		$76,428,265.74
Divisible Surplus (Company's new Standard)		6,651,580.11
		$83,079,845.85

Surplus by the present New York State Standard, i. e., 4 per cent Actuaries' (including the Tontine Fund).....$11,846,793.06

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